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January 28, 1932

Arch Span of Reinforced Brickwork

Calculating Secondary Stresses

New Road Bypasses Michigan Town

A Basis for Construction Revival

Erosion Control at Dams:

. . . Depressed Apron at Hamilton, Ohio

. . . Model Studies at Conowingo Dam

Industrial Plant Construction:

. . . Water and Sewerage Systems

. . . Pedestrian Traffic Tunnels

Ground and Surface Water Rights

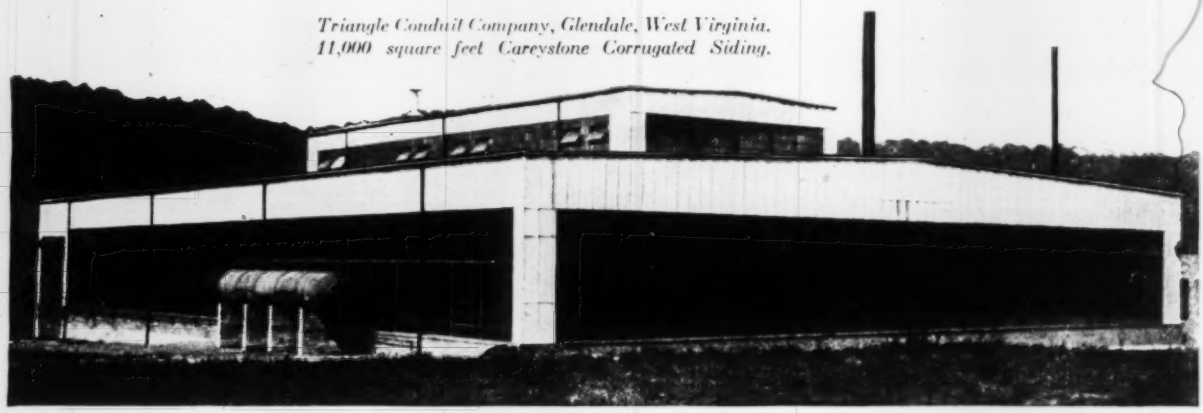
Also

Civil Engineers Meeting At New York

✦

Associated General Contractors At Milwaukee

Laying up reinforced brick masonry in cantilever construction of a 42-ft. span arch bridge



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F. E. Schmitt, Editor

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More Cohesion

THE growth figures of the American Society of Civil Engineers announced at its annual meeting last week point to a trend toward greater cohesion among engineers. The year's economic stress, bearing heavily on civil engineers, undoubtedly tended to discourage avoidable expenditures. That the society's membership should show a net increase of well over 500 under such circumstances is strong evidence of an increasing recognition on the part of engineers of the value of cooperation. Individualism and isolation have long marked the civil engineer's profession; if they are now yielding to a spirit of more active fellowship the change is to be welcomed. With increased cohesion there will develop the greater strength of united action. Individual action, weak at best, is more often lack of action, and when the engineering profession once stands together and effectively expresses its united opinion it will have a brighter day.

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Principles Survive Change

A FITTING remark made by George F. Schlesinger at the meeting in acknowledging the award of the Wellington prize recalls to mind the lasting virtue of basic principle. Mr. Schlesinger said that the teachings of Arthur M. Wellington on the economics of railroad location have been his inspiration and guide in working out the theory of highway location—a remark that gives evidence of farseeing appreciation of the fundamental character of Wellington's epochmaking work. The new conceptions and methods of analysis which he taught are indeed at the bottom of all study of operating values in transportation. Though the mechanical elements of highway operation differ widely from those of railway operation, the problem is the same in its general terms and involves the same underlying economic relations. Though the outward aspect of the art may change, its principles survive.

To Stabilize Wages

A LEADING place among the significant events of the week must be given to the President's action in ordering all departments to enforce the prevailing-rate-of-wages law by abrogating contracts on which it is violated. It is the first clean-cut effort to make effective the intent of the law that existing wage-rates shall be respected in federal building work. What the law was meant to do is perfectly clear, but it remained ineffective because no procedure was prescribed for determining wage-rates, and no penalty was imposed on violation. So long as the rates to be paid are not stipulated in the contract there will still be ground for dispute and for unjust harassment of contractors. But the difficulties will probably be small in respect to the large building program in Washington itself, where wage rates are fairly well established. In any event the new order will make it dangerous to indulge in wage-bootlegging, which it is said has been going on even on some government work, and it will also have a deterrent effect on wage-cutting on federal work generally. By thus promoting wage stabilization it will counteract deflationary forces and therefore should hasten recovery of normal construction conditions. It is also a helpful preliminary to such amendment of the law as will give it fullest effect in safe guarding the interests of worker, contractor and government. Amendments to achieve this result have been proposed by the Associated General Contractors; they deserve study by Congress.

Studying Construction Demand

CERTAIN new views that are crystallizing out from the troubles of the construction arts are set forth clearly by S. E. Thompson in his discussion this week of how construction may be revived. These views concern themselves with the unsatisfactory means through which any demands or needs for construction are made known and converted into action. At present, for example, there are extensive opportunities and needs for new construction, enough to give useful employment to a large part of the idle army of construction craftsmen as well as to those of other industries; but these opportunities cannot become articulate under the many restraints arising from shortage of credit and the resulting paralysis of business initiative. Mr. Thompson suggests that the problem be attacked by engineering study, to discover the needs and demonstrate their economic value. What he says has close kinship to the thoughts set forth recently (*ENR* Nov. 12, 1931, p. 761) by L. L. Baxter, and gives further proof that a critically

questioning attitude toward traditional ideas on construction is growing up. If the new thinking develops as it should, it is bound to lead in time to an organic readjustment of the construction industry.

Windbracing Knowledge

FURTHER progress in dealing with the refractory questions of wind action and windbracing is recorded in the second progress report of the windbracing committee of the American Society of Civil Engineers. Noteworthy points are the successful application of the Cross method to the analysis of rectangular tier-building frames; a discussion of working-stress values, with the recommendation that members carrying wind stress only should not be credited with the excess stresses usually applied to combined load and wind; and the initial data on model wind-pressure measurements, contributed by the Bureau of Standards. The thought and judgment devoted to the work of the committee deserve the grateful acknowledgment of the profession. It is a worthy response to the exceptionally important position that windbracing questions have attained during the past three or four years. What the committee has done to date warrants confident expectation that its labors will ultimately put this field of empiricism and tradition on a basis of sound knowledge.

Better Protection

A USEFUL step toward better protection of public health is about to be made by New Jersey. A bill before the legislature proposes to place the technical operators of water and sewage treatment plants under the state civil service, and thereby remove them from the range of political activity and control. It should have the fullest support of officials and legislators as well as of engineers. To safeguard the wellbeing, even the lives of city populations demands ever-vigilant control of purification processes by men of unquestioned technical skill, and the vigilance and effectiveness of these operators clearly demand freedom from political and administrative subserviency. New Jersey has been a leader in health protection, being first to institute state licensing of treatment-plant operators (as also, at an earlier date, of municipal health officers). It will again be leader in a new advance if it enacts the proposed bill and thereby supplements the existing guarantee of competence by freedom from interference on the part of administrative officials.

Underground Water

ANY legal decision tending to clarify the use of water is important to engineering, but one that by establishing a basic principle removes much cause for future litigation is doubly important. In this light the Arizona decision on underground water rights claims careful notice. Reversing a lower-court decision, the state supreme court declares that under Arizona statute law underground waters must be considered as percolating waters, and therefore not subject to appropriation, unless clear and convincing evidence proves that they flow in definite channels. Such proof is but rarely possible, and the general result of the decision therefore will be to clarify surface rights and protect stream supplies from interminable litigation based on prior-appropriation claims to subterranean waters. Not only did the court state the law but it went farther to point out the results that would follow and their effects on the state's water utilization—the probable curtailment of large-scale pumping development and the strengthening of surface-water development by better assurance. The decision with its thoughtful attention to the law and its effects marks a step of definite progress in simplifying the complicated questions of water law. It will stimulate future development and assist in building a firm code of Western water law.

Work Still to Be Done

IN THE last week or two many cities have curtailed or stopped construction work because of money and credit shortage. Others are on the point of doing so; the movement is spreading. Thus the only field in which activity has remained somewhere near normal is being laid idle, still further shrinking business and credit.

For months public work, not federal but local public work, has been relied upon to bridge over the deepest trough of the great business depression. The national government laid on the local communities the burden of carrying the idle and distressed over the trough. These communities now are compelled to drop the burden, so far without support from the country at large. Yet there is still work to be done, a vast amount, in meeting municipal needs. It can reduce the present unemployment, improve business, and strengthen credit, confidence and buying power. It can give our service agencies something to do—the railways, utilities and industries. Unless the work of the cities be maintained and if possible extended, the present agencies of depression will be rendered even more powerful.

The American Water Works Association has shown how much remains to be done in a single field, half a billion dollars in better water protection alone. Other fields offer still more work. Of the waterworks plan Malcolm Pirnie, one of its framers, has this to say:

> It was formulated as a contribution to all financially sound plans of needed public works which can be initiated to produce employment. The estimated work is national in scope and is not borrowed from future normal betterments. There is as great a need for other public works. In spite of the financial soundness of needed public works—enough to provide jobs for all now unemployed—it is impossible to finance them. There must be a solution to this deplorable condition.
>
> Available information about 1932 budgets for private utilities and for public works of municipalities indicates that construction work this year will not be more than half the amount done last year. This will cause great increase in unemployment and suffering. While engineers and municipal authorities are planning needed public works that are financially sound, those who can formulate a means of providing credit must make money available for the construction of these works at an early date, or this country may have to adopt the dole to keep a large percentage of its population from starvation. We should be able to avoid such a travesty in a land where storehouses are bursting with unmarketable food and other necessities of life.

These words point straight at the heart of the difficulty. There is work to be done in ample amount, but the blocked channels of credit are stopping even the work that has so far continued. Perhaps the newborn Reconstruction Finance Corporation has opportunity to revive the perishing municipal construction activity. Otherwise the problem lies at the door of Congress.

Reinforced-Brick Masonry

A FOUNDATION is being laid for the rebuilding of an ancient art, through the activities of a group of men interested in promoting the use of brick for structural purposes. They are developing tangible knowledge on the use of brick masonry reinforced with steel rods or mesh and in bringing about complete re-education of the engineering profession in the new form of construction. For, so far as this country is concerned, the bold use of brick masonry is a lost as well as an ancient art. On the other hand the past decade (and particularly the past three-year period) has witnessed numerous applications and tests of reinforced-brick masonry that in the aggregate are exceedingly interesting and important. A concentrated and organized effort is now being made to develop new information. The entire course of events warrants consideration and appraisal.

Historically the recognition of the cohesion strength of brick masonry and its ability to resist tensile loads goes back many centuries. To cite only one example, it formed the structural basis of Byzantine architecture and found its most famous expression in the 107-ft. diameter dome of the Church of St. Sophia in Constantinople. In the early nineteenth century Marc I. Brunel conceived the possibility of increasing the tensile resistance of brick masonry by iron reinforcement, and put his theory to use in the brick caissons sunk for the Thames River tunnel, in a test beam of 21-ft. span, in a brick chimney and in a half-arch 60 ft. long built as a cantilever. Today reinforced-brick masonry enjoys moderately extensive use in India and Japan in such applications as floors, columns, stairways and retaining walls, but elsewhere it is a lost art. So far as American engineering practice is concerned it may be considered as new.

Any consideration of reinforced brickwork leads inevitably to comparison with reinforced concrete. Both are composite materials. In each we are concerned with the resistance of the masonry to compressive, bending and shear stresses. And in each the steel reinforcing is so placed as to resist the tensile forces effectively. Tests of reinforced brickwork, while not yet extensive, indicate that it reacts similarly to reinforced concrete and indeed that some of the design values may be very nearly the same, such as a 40 lb. per sq.in. working stress for shear. Brick beams with bottom steel but no stirrups develop diagonal shear cracks as the first sign of stress and fail rather suddenly from slippage of the reinforcing bars, a characteristic noted in similar concrete beams. Thin brick slabs, on the other hand, have failed by crushing of the mortar at the top of the joints, with no apparent bar slippage. Reinforced-brick slabs have shown good resistance to deflection, and recovery after deflection has been especially noteworthy. In the matter of construction economy, reinforced-brick masonry requires less formwork than concrete but requires longer time to construct and necessitates more skilled labor.

These statements are merely indicative of some of the characteristics of reinforced-brick masonry, being more in the nature of comment than of scientific fact because of the present lack of research data. If reinforced-brick masonry is to assume a place of importance in the engineer's tool chest, more extensive and dependable information must be provided on the adhesive properties of various mortars to brick of various textures and porosities, on bond between these mortars and steel rods, on shear values of the mortars, and on the modulus of rupture of the finished brickwork. Brick research groups are busy planning test programs that will supply some of this lacking information, but they are handicapped by lack of financial support. If the brick manufacturers come to their rescue, as they should, present-day engineers may yet be able to surpass the ancients in their own type of structure. And modern building practice should reap important benefits.

A Need and an Opportunity

EVIDENCE that organized contracting has applied itself industriously to daily tasks in a depressing year was conclusively shown in the report of the managing staff of the Associated General Contractors at their convention last week in Milwaukee. Laboring under the handicaps of a curtailed financial budget and a reduced working force, the organization yet maintained its established activities in full strength. Though new undertakings could not be entered upon, the current work of promoting construction and of dealing with problems of legislation, contract simplification, insurance, bonding, bidding practices and lien law reform has progressed.

All told, organized contracting has done well indeed in keeping its existence intact and its daily work accomplished. But its tasks are growing day by day; in the coming years it must do more, if its opportunities for usefulness are to be realized. Clear recognition of this fact was an encouraging feature of the Milwaukee convention.

In its dual activity as the purchaser of the machinery and materials of construction and as the responsible agency for using them to reproduce the owner's and engineer's plans in material form, contracting occupies a coordinating position in the construction industry which gives it large possibilities for leadership. Obviously it can realize its opportunities only by exercising the foresight, deliberative judgment, initiative and executive ability of leadership. This leadership implies something far beyond the mere performance of the current tasks of the day.

To exercise leadership, moreover, it is clear that the A.G.C. must develop leadership within its own organization. As the new year of organization work opens up this is the principal task of the members who met in convention a week ago in Milwaukee. The task is not easy. The elements of the association are loosely knit. Chapters and branches assert rights of autonomy which are virtually subjugating the parent organization. Its own controlling head is a dispersed body. Over all lies the business situation, which limits the money and the consideration that members can divert from their individual business interests to work for advancing common progress and improvements.

These are obstacles which the A.G.C. has to overcome if it is to proceed at all beyond routine duties. They cannot be overcome by the miraculous power of any slogan of policy or resounding announcements of contractors' bills of rights. The means required are wholly commonplace and practical: first, membership and money support; then, a leadership which is direct, positive and endowed with foresight and judgment. The contracting business has the means and the men. It can demonstrate its right to constructive leadership by calling them into service.

Brick Arch of 42-Ft. Span Built Without Falsework

In using cantilever method to erect bridge near Philadelphia, designed to carry 2-ton tractors, reinforced-brick masonry successfully withstands severe test

A NOVEL and in many respects the most ambitious example of reinforced-brick masonry in this country was recently completed in the form of a 42-ft.-span arch bridge at the Melrose Country Club near Philadelphia. It is the more unusual because it was erected without falsework by cantilevering out from either abutment, the brickwork being laid up on short centers suspended from the cantilever arms. The arch has a rise of 6 ft.

Fig. 1—Arch bridge of reinforced brickwork near Philadelphia erected as two cantilever arms without falsework.

The barrel, 8 in. thick and 4 ft. wide, carries 8-in. spandrel walls at either edge that support a precast reinforced-brick deck slab 12 ft. wide. The bridge was designed to carry 80 lb. per sq.ft. live load over the whole deck, or a 4,000-lb. tractor running directly over the spandrel walls. High-early-strength cement was used for the mortar, and reinforcement consists of $\frac{3}{8}$- and $\frac{1}{2}$-in.-diameter steel rods. Shortly after completion the bridge successfully carried a test load of two trucks, two tractors and a closed car.

The bridge and its erection scheme were inspired by an experimental brick cantilever built in 1836 by Brunel, engineer-in-chief of the Thames tunnel in England. Brunel's cantilever or half-arch was erected to a length of 60 ft. and had a rise of $10\frac{1}{2}$ ft. After standing for two years the structure collapsed from undermining of the foundation, but the principle of construction—building without falsework by suspending centers from the end of the arm—had been proved practicable.

The designer of the present bridge, Judson Vogdes, engineer-manager of the Common Brick Manufacturers Association, in Philadelphia, had long had a desire to erect a bridge of moderate span on Brunel's principle, particularly since recent test work had shown the wide adaptability of reinforced-brick masonry. Accordingly, when it was learned that the Melrose Country Club would have to replace several footbridges that had been washed out in a rather severe storm, preliminary sketches were made of the proposed scheme and submitted to the officials of the club, who approved them. The local group of the Common Brick Manufacturers Association also, on being advised of the program, authorized Mr. Vogdes to proceed with the plan and agreed to furnish the necessary brick without cost. The original scheme called for a footbridge to be used in connection with the eighteenth fairway, but the management of the club felt that it would be desirable to erect a bridge that would carry tractors and mowing machines as well. Accordingly, the special design described here was developed.

Fig. 2—Masons laid up brick or wood center hung from completed part of arm, which was moved forward half its length every second day by virtue of the use of high-early-strength cement mortar. In background a mason is building floor slabs to serve initially as counterweights on the anchor arm of the cantilever.

Design

In fixing the size of the arch it was necessary to consider that tractors are about 4 ft. wide, while mowing machines require a clear roadway of about 10 ft. On the other hand, the weight of the tractor, 4,000 lb., distributed on four wheels, determined the capacity for which the bridge had to be designed. The arch ring was made 4 ft. wide and 8 in. thick except at either face, where it is increased to 12 in. for appearance. Spandrel walls at either edge of the arch ring are 8 in. thick. To provide the 10-ft. width required by the mowing machines, precast deck slabs 12 ft. wide, including curb beams, were used, extending out 4 ft. either side of the spandrel walls.

The mortar in all cantilever construction was of a rather unusual mix, consisting of two parts high-early-strength

Fig. 3—With each arm 17 ft. long, the remaining 8-ft. gap was spanned by a center, as shown, and the closure brick-masonry placed.

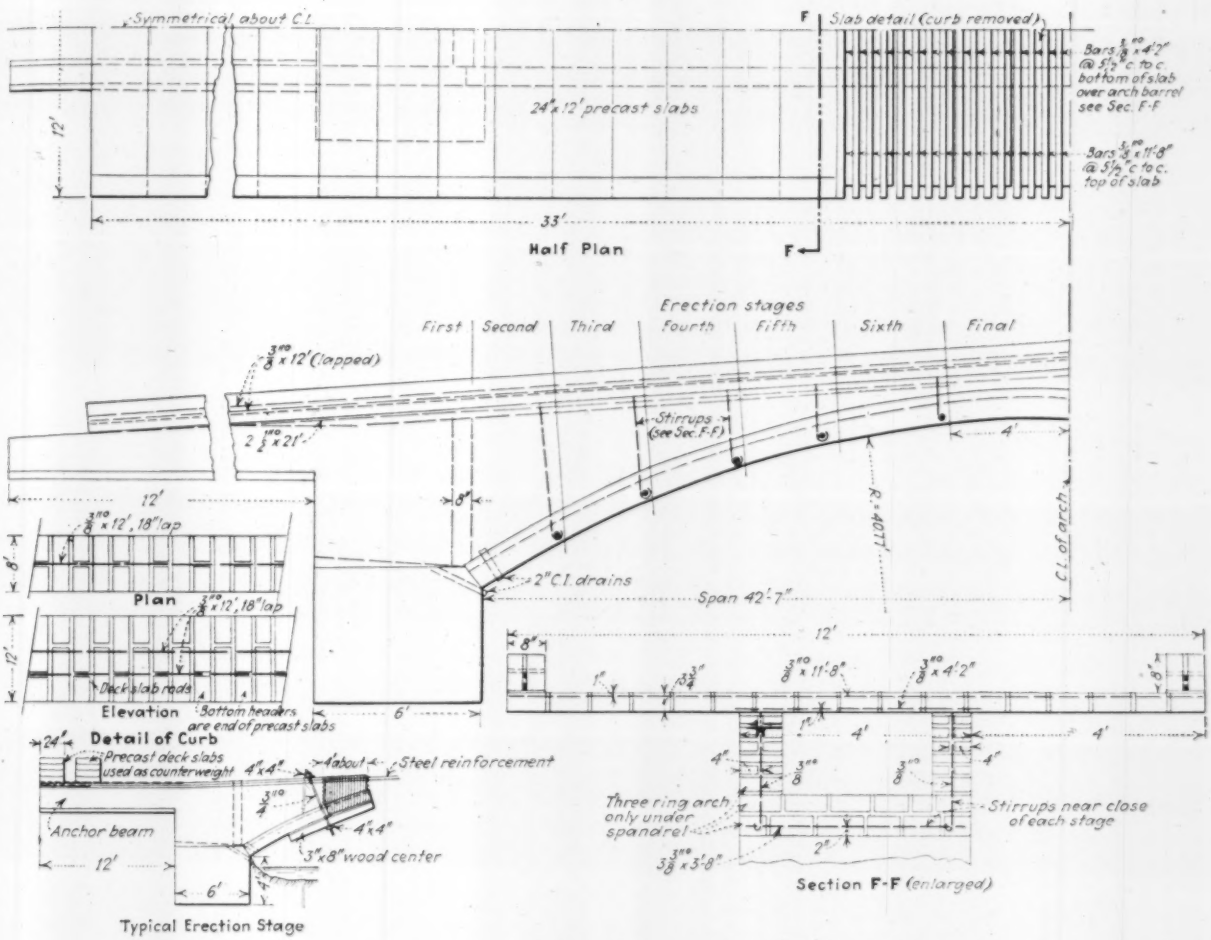
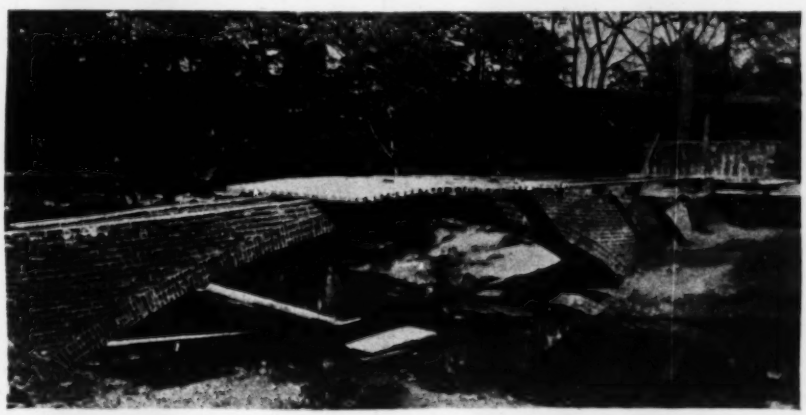


Fig. 4—Design details and erection scheme for 42-ft. reinforced-brickwork arch.

portland cement, one part natural cement and six parts of sand. This mortar proved entirely satisfactory, giving a strength at the end of 24 hours sufficient to allow the use of the work under load. The natural cement was used to give plasticity and workability to the mix. In the construction of the precast deck slabs, straight portland cement and lime, mixed 1½ :1 :6, were used with excellent results.

The design of the deck slab, although based upon a theoretical analysis, was in a large measure determined by the results of tests on seven slabs built in plants around Philadelphia. The curb beam along either side of the deck was placed to give added stiffness to the slab and at the same time to tie the precast slab units together.

Fig. 5—Precast floor slabs were moved on rollers from the counterweight pile over the anchor arm to their place in the bridge.



The design of the brickwork, including the location of the reinforcement, is shown in Fig. 4. The stirrup rods shown in the spandrel walls were placed to tie the arch ring to the tension side of the anchor beams. They and the other spandrel reinforcing served only during erection, for when the closing section was erected between the cantilever arms the structure became an arch in which only compressive stresses existed.

Erection

Construction of the arch began by building brick abutment caissons 6x8 ft. in plan and 2½ ft. deep, and sinking them to gravel by excavating inside. The caissons were reinforced with a ¼-in.-diameter rod in the bottom and top brick courses, running continuously around the structure. On these abutments the brick masons laid up the land portions of the bridge.

In order to erect the half-arches as cantilevers, some sort of anchor was necessary. This was provided by extending the spandrel walls shoreward as two anchor beams about 2 ft. deep, 8 in. wide and 12 ft. long. The first plan was to counterweight these with the loose brick destined for use in the

Fig. 6—Reinforced curb beam laid up after floor slabs were in place served to tie them together and to resist the negative bending moment in the part of the slab that overhangs the spandrel walls. Note in right foreground the soldier brick set in the notches in the edges of the floor slab and serving to bind curb and slab together.

floor slabs, but this was abandoned in favor of the more efficient scheme of laying up the floor slabs at the same time as work on the cantilever arms progressed, utilizing the completed slabs as the counterweights.

The arch-erection scheme is illustrated in Fig. 4. A simple wood center about 10 ft. long was hung from the completed portion of each cantilever arm, as shown, and the arch ring and spandrel walls extended in 4-ft. sections, the masons working on the center, as shown in Fig. 2. The work progressed continuously, as it was possible (by virtue of the use of the high-early-strength cement) to complete a 4-ft. section on each arm every second day. Final closure was made, when each of the arms was 17 ft. long, by suspending the center as shown in Fig. 3 and filling in the remaining 8-ft. opening.

With the arch ring and spandrel walls complete, the precast deck slabs were placed on skid boards and rollers and moved into position, set for line and grade by means of small blocks and attached to the bridge by pointing the space between the slabs and spandrel walls with mortar. A ½-in. joint was left between adjoining slabs, and this joint filled with grout, a form board being wired in place beneath the joint. Thirty-seven 2-ft. slabs were placed over the bridge.

As shown in Fig. 5, the slabs as placed were without curbs and had toothed edges. Boards hung beneath the slabs provided support for the soldier brick, which were set in the toothed openings and bonded to the floor-slab brick by mortar pointing and grouting. The curb was then built up as shown in Figs. 4 and 6, providing a double reinforced beam with a depth to steel of 8 in. from either face. An advantage in setting the curb beam to line and grade after all slabs were placed, instead of precasting it along with the slab sections, was the possibility of eliminating the effect on appearance of irregularities in the slabs.

In erecting a reinforced-brick arch by this method shrinkage stresses are reduced to a minimum and those that do exist are taken care of as erection proceeds, in this arch after the completion of every 4-ft. section. Also the arch ring is continuously in compression. According to the designer there was no apparent deflection at the crown upon the removal of the center or upon the application of the deck load.

The structure required 20,000 bricks, including those used for the mass masonry in the foundations. Ground was broken on Sept. 29, 1931. On Oct. 6 the foundations, abutments and anchor beams were completed and work started on the arch. On Oct. 19 the arch ring was closed. Twelve days of bricklayer time were required to complete the arch and spandrel walls. During this time one bricklayer did most of the arch construction, while the other built the precast deck slabs.

The bridge was designed by Judson Vogdes and erected under the direction of Albert Welchly, respectively engineer-manager and assistant engineer of the Common Brick Manufacturers Association in the Philadelphia district.

Planning Water and Sewer Systems for a Large Industrial Plant

Three water-supply and two sewerage systems at Point Breeze works of the Western Electric Co.—Underground piping to meet ultimate requirements installed in partly developed area

By E. D. George and F. W. Buck
Mechanical Engineer, Western Electric Co., and Chief Mechanical Engineer, The H. K. Ferguson Co.

IN SELECTING a site for the third major manufacturing plant of the Western Electric Co., facilities for shipment by water, as well as by rail, were of particular importance because of the anticipated production of submarine cable. Advantages in this regard led to the selection of a tract at Point Breeze, Baltimore, Md., despite the fact that this site had only a limited city water supply and little or no sanitary or stormwater drainage. Provision for an adequate water supply and for sewerage became an immediate problem, which was solved, as herein described, with the cooperation of the engineers of the city of Baltimore.

The layout of present and future manufacturing units in relation to the highway and adjacent waterways is shown in Fig. 2. Experience in the construction of the two previous plants made it possible to estimate closely the number of employees, the quantities of water that would be required for domestic and manufacturing services, and the amount and character of process and industrial wastes to be collected and disposed of. As it is generally conceded that economy is served by installing underground services of sufficient size for ultimate requirements, no estimation of the period of growth of the plant was necessary.

Fig. 1—Installing a 42-in. concrete storm sewer at Point Breeze plant.

Water supply

Careful study of plant water requirements indicated the advisability of providing three water-supply sources: city mains, the adjacent Patapsco River and driven wells. City water is used mainly for house service, drinking water, fire protection, boiler feed and in manufacturing processes requiring pure fresh water where a high summer temperature of 75 deg. is not objectionable. A number of plant operations, however, require cooling water at lower temperatures than can be secured from either city mains or the river. These are served by wells. Water from the third source, the Patapsco River, is used for cooling air compressors, ice machines and for some manufacturing processes.

City Water—A 12-in. main entering the property at the southwest corner temporarily supplied the initial demand, while the city built a new 20-in. main to provide capacity for the ultimate plant. As the new main is dead-ended at the east end of the property, it affords, for the present, only a one-way supply. The two city mains have been connected by a 16-in. line to provide some protection

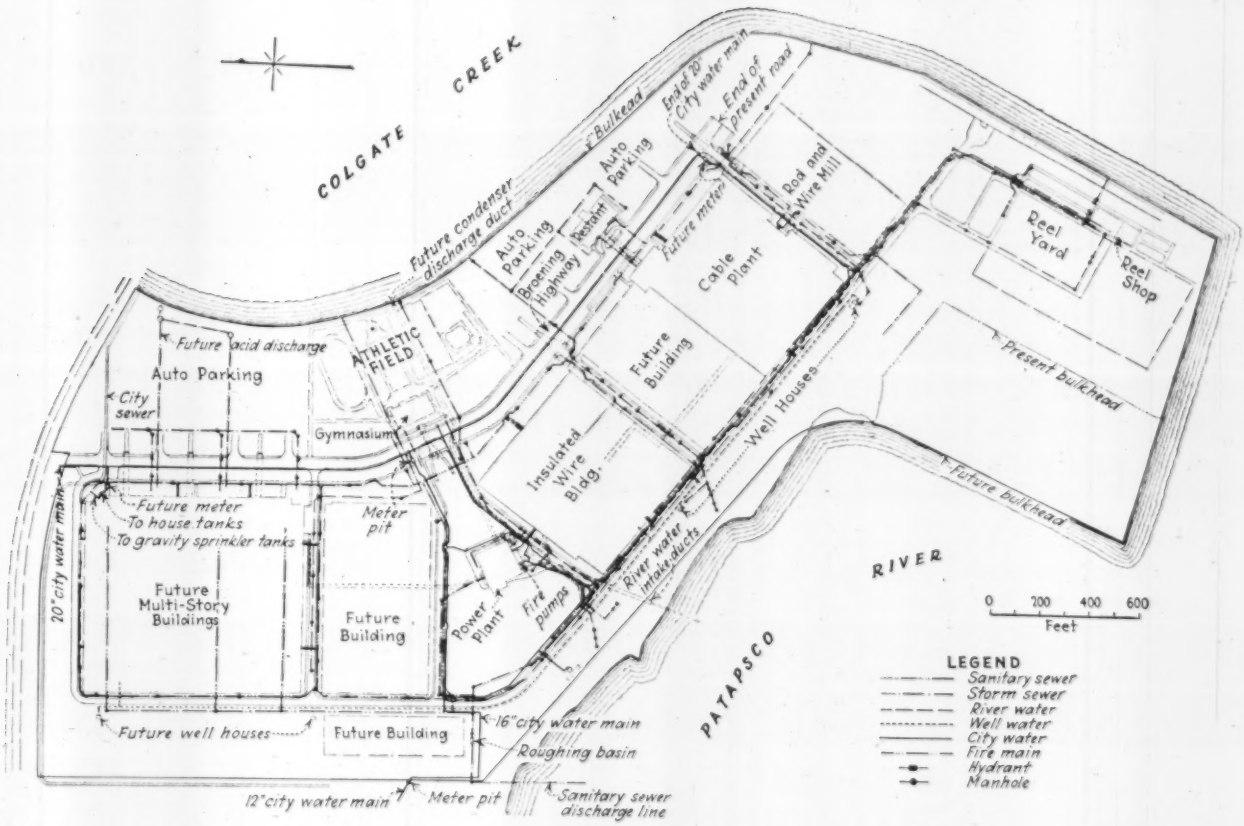


Fig. 2—General layout of Point Breeze plant, Western Electric Co., showing water and sewage services.

in case of a shutdown of the 20-in. main; eventually the latter will be extended across a highway bridge to be constructed over Colgate Creek and joined to the city system in the Sparrows Point territory. Present and future meters on the city connections are located so as to assure uninterrupted service at all times.

In planning the drinking-water system, some thought was given to the use of small cooling units in the separate buildings, but it was finally decided to locate a central cooling system in the power house where it would receive closer supervision and where possible leaks in the refrigerating lines would not affect manufacturing. City water is chilled in a large tank by a 100-ton refrigerating machine and is circulated by centrifugal pumps. Make-up water is filtered and ozonated, provision also being made for the ozonation (for a part of the day) of the return water from the circulating system. Ozonation has resulted in a steady decrease in the bacteria content. The entire drinking-water system is insulated to maintain a minimum drop in temperature and is washed out periodically.

The fire-protection system is entirely separate, with a main connection to the city system at the power house, where two turbine-driven fire pumps are installed. Two 50,000-gal. tanks in a building tower will be built to maintain a constant static head on the automatic sprinkler system until the fire pumps can be started. An underground fire main is looped around each group of buildings, with sectionalizing valves so located that any part of the main can be shut down with a minimum of unprotected area. Valves in pits outside the buildings connect the underground mains with the automatic-sprinkler system. Standard two-way hydrants are located at 250-ft. intervals along all main-plant roads.

Well Water—By direct pumping without the use of storage tanks it is possible to deliver water from the wells to certain processes at a temperature of 59 deg. The two wells now in use are similar, both having a depth of 300 ft., a 28-in. outer casing and an 18-in. intercasing. The motor-driven centrifugal pumps have bowls 154 ft. below the surface. As delivery is 800 and 1,000 g.p.m., respectively, either well will supply present requirements. When consumption expands, more will be drilled at 1,000-ft. intervals. The water is obtained from a gravel stratum containing considerable fine sand that is removed by hand traps of the tank type at each well. Distribution to the manufacturing buildings is through a separate underground system. Although used only for manufacturing processes, analysis indi-

Fig. 3—Typical syphon chamber on Point Breeze storm-sewer system.

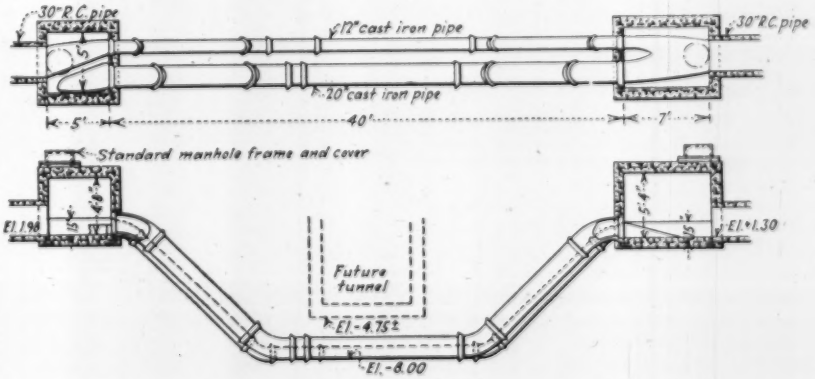


Fig. 4—Point Breeze plant storm sewer discharges into the Patapsco River.

cates that this water is suitable for drinking or boiler feed, and provision will be made for the delivery of surplus quantities to house tanks for general use.

River Water—In designing the power house, provision was made for the possible future installation of turbines, and two concrete intake ducts 6 ft. square were built to the Patapsco River for condensing purposes. With these intakes available, it was thought economical to use river water as a cooling medium for power-house equipment and for some processes in the manufacturing buildings. The water is circulated by specially designed motor-driven centrifugal pumps, two of which deliver 1,000 g.p.m. each against a pressure of 130 lb. per sq.in., and two others with capacities of 900 g.p.m. at 75 lb. As near-by users of this water had experienced trouble due to the chemical content and a vegetable deposit in the underground mains, the cooling units are designed for easy cleaning and replacement and the mains provided with cleanouts. Pipes over 2 in. in diameter are of cast iron; smaller ones are of brass.

Sewers and drainage

Sanitary Sewer System—To fit in with city plans for a disposal plant north of the property, it is necessary to discharge all sanitary sewage at a single outlet on the bank of the Patapsco River. Pending completion of the city system, a temporary roughing basin discharging into the river has been installed. The sanitary system is designed for a larger per-capita capacity than is required by the city because of the possibility of discharging some industrial wastes into it. Although there are no funnels, ducts, pits or syphon chambers, the grade established for the future city line made it necessary to install ejector pumps in one building.

Stormwater System — Roof, road, track, surface and subsoil drainage, as well as waste from various manufacturing operations, are discharged through the stormwater system. Design was based upon the McMath formula (found in Metcalf and Eddy's book on sewer design), together with the city of Baltimore's rainfall intensity curve $I = \frac{105}{t - 10}$ in which I equals intensity in inches per hour and t equals time of concentration in minutes. At the request of the city the initial time lag used was 5 min. Kutter's formula was used in figuring velocities and pipe sizes. Due to the low-head differential available it was not always possible to maintain self-cleaning velocities; in such cases the smaller sizes were given self-cleaning grades, and low tides and heavy storms were depended upon for periodical scouring of the larger pipes.

The stormwater system discharges into Colgate Creek at four points and into the Patapsco River at one. This results in greater dilution and minimizes the pollution of the streams. Because of underground tunnels for service mains and equipment it was necessary to construct a number of syphon chambers, which, although undesirable, have given no trouble to date. Fig. 3 shows the design used.

The disposal of dye tank and acid drainage presented a serious problem. City and state requirements limit the acidity of discharge into the river to a maximum pH value of 2. This is obtained by discharging highly acid wastes into storm sewers that carry considerable cooling water to give high dilution.

Concrete roads on plant property are drained into the stormwater system. Smooth inlets of the self-cleaning type connect with the main sewers through 15-in. pipes.

The plant area is divided into two separate sections by a new city highway, which was paved at an early date to handle motor-truck traffic and employees' automobiles. To avoid tearing up this new pavement, it was necessary to analyze carefully all underground requirements and to install promptly all structures needed to meet immediate and future requirements. All this design and construction was subject to the approval of the city of Baltimore. Both sanitary and storm sewers outside of buildings are of vitrified-tile pipe in sizes up to 24-in. diameter. Larger units are of reinforced-concrete pipe except under railroad tracks, where cast-iron pipe is used. Manholes are installed at all pipe intersections and at 300-ft. intervals on straight runs.

Seven Highway Underpasses Protect Point Breeze Workers

By W. J. Pampel
Design Engineer, Western Electric Co.
and F. W. Daniels
Project Engineer, The H. K. Ferguson Co.

IN PLANNING the development of the Point Breeze works of the Western Electric Co., in Baltimore, Md., which will ultimately house 30,000 employees, the need was recognized for a system of pedestrian subways under a main highway and a double-track street railway traversing the tract. These traffic arteries separate the main manufacturing units and plant buildings from the restaurant, athletic field and parking space for 3,500 automobiles, introducing potential hazards to employees and delay to traffic at certain periods of the day. Although the underpasses are not urgently needed at the present stage of development, construction in advance of the paving of the street, which was done at an early stage, was deemed advisable to avoid future interference with street and rail traffic.

The planning and design of ramps and tunnels to care for ultimate needs required considerable study, particularly of such questions as the ultimate number of persons that would use the passages, the effect of ramp pitch upon capacity and the construction details. Actual checks at the company's other plants showed that, at quitting time, from 40 to 50 per cent of the employees leave the building exits within three or four minutes. Knowing the number of occupants in the various manufacturing units

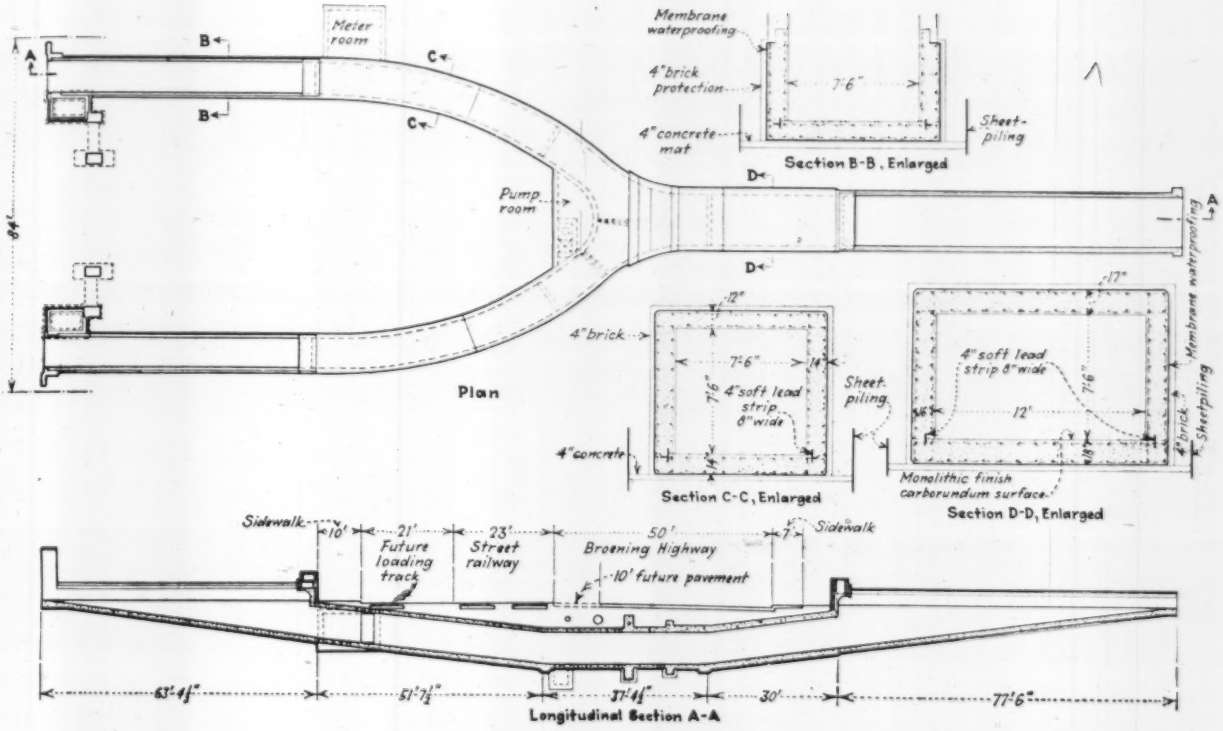


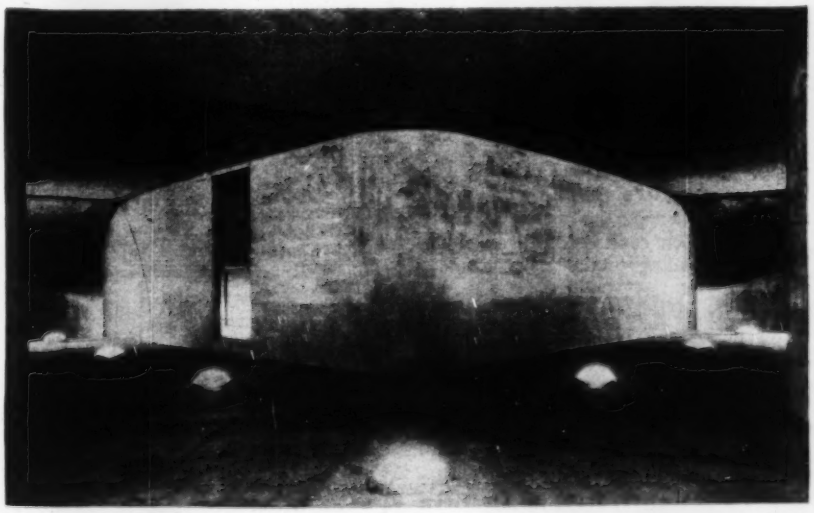
Fig. 1—Design details of a typical twin-ramp underpass for workers at new Point Breeze plant of Western Electric Co. at Baltimore.

at Point Breeze, it was possible to arrange toilet facilities, lockers and time clocks so as to determine the flow of personnel through each of the proposed subways.

Formulas for determining the proper width of passages and ramps were based upon a modification of the stairway code, checked by actual counts of the pedestrian traffic carried by ramps at a number of large modern stadiums. Based upon one-way traffic only, the condition that obtains during congested periods, it was found that ramps would accommodate between 25 and 30 persons per foot of ramp width per minute.

In determining ramp pitch a balance was struck between ease in walking and economy in construction, as affected by the length of ramp required to provide headroom. In the opinion of the designers, changes in pitch, within the limits of comfortable walking, had a negligible effect upon capacity. The slope finally adopted was 16 in. per 10 ft. of travel, giving each passage a length of about 250 ft. Construction features of a typical unit are shown in Fig. 1, while Fig. 2 is an interior view of a completed double-ramp subway. No coverings are provided over the ramps, as the severity of winter weather in Baltimore does not justify this expenditure. However, as a safety measure, carborundum grits were troweled into the floors, and they were given a rough wood-float finish producing a non-skid tread. Recessed ceiling lights provide illumination.

Fig. 2—Dual approaches merge into single tunnel under street.



Seven underpasses were constructed, three of which have twin-ramp entrances on the plant side. The locations are shown in Fig. 1 of the preceding article, p. 121. The double entrances are each 7½ ft. wide, merging into a single subway 12 ft. wide. A single tunnel-type underpass, 9 ft. in width, connects the main manufacturing building with the restaurant. Tunnels built integrally with two of the passages carry water and steam pipes, electric conduits and other services between buildings. These tunnels are of the same height as the passage, with a width of 3½ ft.

Waterproofing was an important problem, as the low point of the tunnels is 6 ft. below the normal level of the rivers adjoining the property. A very dense concrete was used, and the entire passage was coated with a five-ply waterproof membrane. This construction made it necessary to build the tunnel proper on a separate base. Each passage is provided with bronze-grill floor drains connected to a pit fitted with an automatic sump pump. Wrought-iron gates close off the passages when not in use.

New Road Bypasses Village and Eliminates Railway Crossing

Long, high fill and a three-span concrete and steel grade-separation structure with concrete swaybraces in the steel spans built by Michigan highway department

REDUCING a long and winding 11 per cent highway grade to a maximum of 6.8 per cent and eliminating a railway grade-crossing at the foot of the hill has been effected in the adjacent villages of Benzonia and Beulah, Mich., by a new bypass road and grade-separation structure built in 1931 by the Michigan state highway department. The new bridge, spanning the railway and two streets, is shown

Fig. 1—Central concrete span of Beulah grade-separation bridge over Ann Arbor Railroad is combined with steel side spans having concrete swaybraces over streets.

in Fig. 1, with a plan and profile of the old and new routes in Fig. 2.

An old township road descending the Benzonia Hill on a grade averaging 11 per cent was taken over by the state when it adopted the trunk-line system and the road became a part of one of the most heavily traveled routes in the state. This route has been improved progressively within recent years, but when it became necessary to extend the concrete paving through these villages to Honor, Mich., it was evident that the old hill location could not be utilized as a modern highway owing to its steep grade and sharp curves and particularly the railway crossing at the foot of the hill. Topographical conditions required a bridge over the railway, but the north approach to a structure on the original location would have involved a heavy fill along the main street of Beulah, with consequent heavy expense for right-of-way and property damages.

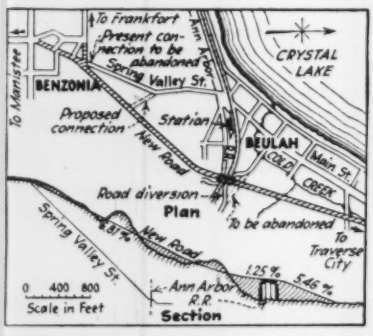


Fig. 2—Road diversion eliminates steep grade and railway crossing on Spring Valley and Main Sts.

It was necessary, therefore, to relocate the road, but at the same time to avoid isolating the villages and to provide easy access from the new route to them. From the top of the hill the new road descends by grades of 6.8 and 5.46 per cent, reduced to 1.25 per cent over the bridge. The approach to the grade separation consists of 1,600 ft. of fill, with a maximum height of 38 ft. and about 2,900 ft. of cut and fill, the total amount of fill being 146,500 cu.yd. A 3-deg. curve is introduced below the heaviest grade, the paving being given a superelevation on the curve. A short inclined branch connects with an existing street leading to the main business thoroughfare.

Gravelly clay and sand is the main material for the fill and was dumped from motor trucks. Since twelve months are to elapse between grading and paving operations, no compacting was done, but a shrinkage allowance of 15 per cent was provided. With a 36-ft. concrete roadway and curbs and gutters, the normal width of fill is 48 ft., as shown

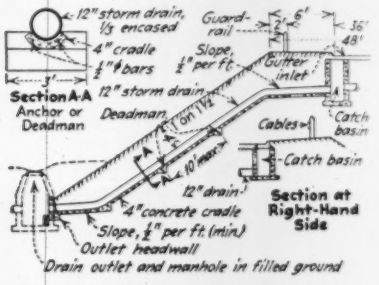


Fig. 3—Catchbasins and inclined drains carry surface water from roadway without damage to shoulders or fill.

in Fig. 3. Post-and-cable guard rails are placed 2 ft. from the edges, leaving 4-ft. unpaved shoulders. The side slopes, about 1 on 1½, are to be dressed and sodded to prevent erosion and give a good appearance.

Drainage of surface water from the road had to be given careful attention. Large catchbasins under the curb, with grated inlets, are provided about 300 ft. apart. Opposite catchbasins are connected by 12-in. sewer pipe with cemented joints, and each catchbasin on the west side has a similar drain in a trench leading down the slope of the fill, opening either into a drainage ditch or to Crystal Lake. The inclined drain, 4 ft. below the face of the slope, is laid on a 4-in. segmental cradle of concrete, which is anchored in place by transverse ribs or deadmen, as shown.

A three-span bridge over the railway and two streets (diverted to pass under the bridge) carries a 36-ft. roadway and two 3½-ft. sidewalks. The 48-ft. reinforced-concrete central span over the railway is of the T-beam type. Two side spans of 69½ ft. have eight lines of steel plate-girders carrying a 7½-in. concrete deck slab, on which is the paving slab, 3 in. thick at the curbs and 5¼ in. at the middle.

Clay tile conduits embedded in the sidewalks provide for electric wires and cables and small gas mains, as shown in Fig. 4. They serve to decrease the dead load and are of the maximum size permissible for the standard 10-in. height of

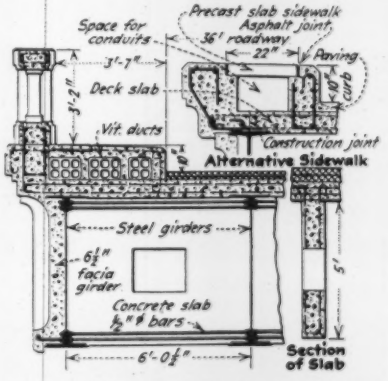


Fig. 4—Sidewalk and concrete swaybraces. Section at right shows new sidewalk design, eliminating tile ducts.

curb. This unusual sidewalk and conduit construction is the result of conferences with utility companies, which within the past two years have greatly increased their demands for carrying wires, cables and small gas mains across the highway bridges. With the conduit system the use of poles on the bridges is eliminated. When gas mains are permitted, they are required usually to be carried between the steel girders and supported on steel diaphragms, so that they are open for inspection. Small mains can be placed in the conduits, but with poor facilities for inspection.

As mortar edges at the joints of the tiles, however carefully laid, are found to scratch the lead sheathing of cables seriously, the electric companies are abandoning the tile for fiber conduits laid in concrete. This has involved a change in sidewalk design of the bridges, removable slabs being provided and the conduits placed along a shelf underneath and near the railing, while steel diaphragms between the girders serve to carry small gas mains. This alternative sidewall construction is also shown in Fig. 4.

Abutments of the skeleton type are built on rigid frames, which are designed to reduce the overturning pressure of the high approach fills. By the construction of retaining walls to limit the end slopes of these fills, the width at track grade can be increased to provide for additional railway sidings without encroaching on the streets. Provision is made for an ultimate street width of 30 ft. and one 5-ft. sidewalk in each of these side spans. The two intermediate piers are three-column concrete bents with cap girders, the outer columns being protected by massive concrete bumpers. Precast concrete piles are driven to carry the piers and abutments on the light soil, with footings high above groundwater level. Concrete fascia girders conceal the steel girders and support the balustrade, which was cast in place.

A detail that is unusual, though standard with the Michigan highway department, is the use of reinforced-concrete slabs as swaybraces between the steel girders. These slabs (Fig. 4) are spaced about 13 ft. apart in each row, but those of alternate rows are staggered. They are 9 in. thick, each with a hole 21x23 in. at the middle. Their horizontal reinforcing rods extend through holes in the girder webs, while the vertical rods are hooked over the reinforcement of the deck slab. Similar slabs, but solid and 15 in. thick, to form backwalls, are cast between the ends of the girders over the piers and abutments.

This road diversion was designed and built under the direction of G. C. Dillman, state highway commissioner; Clifford E. Foster was chief engineer and C. A. Melick bridge engineer. The contractors were Alex. Jeffry, Saginaw, Mich., for the earthwork, and Walter Toebe & Co., Shingleton, Mich., for the bridge.

Designing Plate-Girder Webs to Resist Bending

By Harold D. Hussey
Designing Engineer, American Bridge Co., New York, N. Y.

THE WEB of a plate girder performs the two important functions of resisting shear stresses and assisting in resisting bending stresses. Either of these stresses may cause the web to buckle if the girder is not properly designed. The design of the web to resist shear is treated in all textbooks on the subject. The proper spacing of stiffeners to enable the web to resist shear without buckling was discussed by O. E. Hovey in an article in *Engineering News-Record*, March 12, 1931, p. 446. The present article will discuss the design of the web plate to enable it to resist bending stresses without buckling.

Prof. S. Timoshenko has investigated the buckling of web plates in a paper, "Problems Concerning Elastic Stability in Structures," in *Proceedings*, Am. Soc. C. E., April, 1929, p. 869. Professor Timoshenko's formula for the elastic stability of the web plate when subjected to normal stresses is

$$S_{cr} = \frac{k \pi^2 D}{h^2 t} \qquad (1)$$

in which

S_{cr} = critical unit compression at which web plate begins to buckle.
h = clear height of web plate.
a = length of web-plate panel.
t = web-plate thickness.
k = coefficient which varies in a complicated relation with the ratio h/a.

$$D = \frac{E I}{\left(1 - \frac{1}{m}\right)^2} \text{ and for a plate } = \frac{E t^3}{12\left[1 - \left(\frac{1}{m}\right)^2\right]}$$

E = Young's modulus.

$\frac{1}{m}$ = Poisson's ratio.

Assuming $E = 29{,}000{,}000$ and $\frac{1}{m} = 0.30$, equation (1) reduces to

$$S_{cr} = 26{,}210{,}500\, k \frac{t^2}{h^2} \qquad (2)$$

and

$$t = \frac{h}{5{,}120}\sqrt{\frac{S_{cr}}{k}} \qquad (3)$$

Professor Timoshenko has evaluated k for various values of h/a. For the web plate where the unit bending stress is maximum, $k = 24$ is a very close approximation.

For any given design of girder, equation (2) yields a value of S_{cr} at which buckling of the web plate is imminent. Equation (3) gives the thickness of plate that will buckle at a predetermined value of S_{cr}. When designing a girder the thickness of web should be chosen so that the value of S_{cr} in equation (2) bears the same relation to the value of the given unit bending stress that the tensional yield point of the material bears to the specified basic tensional unit stress. Hence for S_{cr} may be written fs in equation (3), in which s is the maximum gross unit bending stress in the clear web and f is a factor of safety. If k is assumed equal to 24, equation (3) reduces to

$$t = \frac{h}{25{,}000}\sqrt{fs} \qquad (4)$$

Equation (4) shows that the required thickness of web plate is independent of the strength of the material, as measured by the yield point, but that it depends on the unit stress in the web. A web plate of higher yield point should thus be thicker than a carbon steel plate, as illustrated in the following example.

Consider a girder of carbon steel designed for a basic tensional unit stress of 16,000 lb., with a web 98 in. deep, where $h = 82\frac{1}{2}$ in. and $s = 11{,}400$ lb. For this case $f = 2$ and from equation (4) the required web thickness is

$$t = \frac{h}{165} = 0.50 = \tfrac{1}{2} \text{ in.}$$

If, in the example above, the girder were made of silicon steel with a basic tensional unit stress of 24,000 lb., s would equal 17,100 lb., and the required web thickness would be

$$t = \frac{h}{135} = 0.61 = \tfrac{5}{8} \text{ in.}$$

If, furthermore, the girder above had a carbon-steel web plate and a silicon-steel flange, with basic tensional unit stresses of 16,000 and 24,000 lb., respectively, s would equal 17,100 lb. and the required web thickness would be $\frac{5}{8}$ in., the same as for the silicon-steel girder.

Denmark to Build Big Bridge

The Danish government will build a bridge between the islands of Masnedo and Falster, for which the claim is made that it will be the longest bridge in Europe. It will be about 10,630 ft. long, with 18-ft. width of roadway. The bridge will cost about $10,000,000 and will be completed by 1939-40.

Ground and Surface Water Rights Cleared by Decision

Arizona Supreme Court holds that groundwater supplies cannot claim appropriation rights unless existence of underground streams is clearly proved

By Thos. H. Means
Consulting Engineer, San Francisco, Calif.

SETTLING an important point in water law, the Arizona Supreme Court has reversed a lower-court decision and definitely established the doctrine that groundwater is to be considered as percolating unless proved to flow in channels "by clear and convincing evidence." Since Arizona law holds that only water flowing in channels is subject to appropriation, the decision assures the developer of surface waters against interference by claims to subterranean waters established by inference and doubtful evidence as to the presence of underground channels.

The Supreme Court decision reversed the ruling of the Superior Court of Maicopa County (*ENR*, Dec. 8, 1927, p. 926) in a suit brought by the Southwestern Cotton Co., subsidiary of the Goodyear Tire and Rubber Co., against the Maricopa County Municipal Water-Conservation District. The importance of the case to irrigation development, existing as well as future, was recognized by the Supreme Court in the opening of its decision; "Heretofore the development of the subterranean waters has been of comparatively minor importance. We think, however, this case is proof that the time has come when it is necessary for the protection and guidance of future agricultural development in the state that these principles should be enunciated as clearly and definitely as possible, so that our citizens may know how to guide their future procedure."

Main facts of the case

The litigation arose over the construction of the Frog Tanks, or Lake Pleasant storage reservoir on the Agua Fria River about 30 miles northwest of Phoenix. The river drains 1,500 square miles of mountains, and at the point where it enters the plain or valley it has no sustained flow; its floods are very irregular and are separated by long periods when the wide sandy bed is dry. The average yield of the river is 250,000 acre-ft. per year, the flow varying from nothing to more than 100,000 sec.-ft. The reservoir, with a capacity of 170,000 acre-ft., has been built near the point where the channel leaves the mountains and will store the entire floodflow except in wet years.

The Southwestern Cotton Co. owned lands on both sides of the river below the dam and had bored a number of wells and used the water for irrigation. A few of the wells were close to or in the riverbed, but most of them were scattered over the valley miles from the river. The company claimed that, by prior appropriation through its wells, it had acquired a right to the floods to the extent of its irrigation requirements.

Opposing contentions

Trial of the case occupied nearly three months, the greater part of the time being occupied with testimony of engineering and geological experts. The cotton company contended that the waters sinking in the Agua Fria sandy bed fed the wells directly and that there were known underground channels from the river to the wells. To include all the wells it was necessary to show that theoretic channel or channels covered a wide area, as the wells were spaced at about half-mile intervals and some of them were several miles from the river.

The opposing theory was based upon the geological history of the valley as evidenced by the present physiographic features. It contended that there has not been a great deal of change in the way streams act; that the Agua Fria River and other agencies are building up the valley today just as they did many thousand years ago. Conditions underground so far as flow of water is concerned may be determined by assuming that in the past the stream acted as it does now, building up a channel by deposition of sediment and by breaking over its banks and starting new channels, so that there is a crisscross arrangement that leaves lenses of material coarse in grain interbedded in fine-grained sediments, the whole area thus being a heterogeneous deposit without regularity of stratification and with no known stringers of material capable of forming continuous aquifers. Wells in almost any place in such a debris fan will encounter water, and the whole body of groundwater takes on all the characteristics of a body of percolating water slowly moving toward the outlet to the valley rather than moving in a series of underground channels.

The lower court accepted the theory of underground channels, even though this required conceiving a stream that started at the canyon mouth and fanned out to a width of 8 miles or more. The situation was complicated by the fact that many other sources of water contribute to the groundwater body in the valley, including the percolation from other streams and from the large area of sandy desert during cloudbursts, and seepage from the 200,000 acres of irrigated lands in the Salt River project.

In reviewing the case the Supreme Court showed that there has not been any departure from a recognition of the distinct difference between water flowing in channels and percolating water. In Arizona only water flowing in channels is subject to appropriations, and the presumption is that underground waters do not flow in channels but are percolating in their nature. "He who asserts that they are not must prove his assertion affirmatively by clear and convincing evidence." From the evidence the court concluded that, "There is not a scintilla of evidence in the record from which the ordinary man or even the trained scientist could point out definitely a specific place where any one of the so-called subterranean water courses begins, where it ends, or how far its banks extend."

Channels must be proved

With the law established and the mass of evidence introduced in the case so tersely summed up in one sentence, the court then summarizes the effect of its decision in the following words:

> Surface waters (waters subject to appropriation) are plainly visible, definitely ascertainable, and the effect of their appropriation generally easily foreseen and understood by all. Subterranean waters are necessarily more or less uncertain as to their very existence, speculative as to their character, and frequently incapable of an immediate demonstration of the results of their appropriation of such a nature that investors may safely stake their funds and farmers their future on the success of the project. If percolating waters are subject to the law of prior appropriation, and if appropriation of other subterranean waters may be established by mere surmise, inference or possibility, the field is open to interminable and uncertain litigation from which none will profit in the end but members of the legal profession, and there will in all probability be a complete cessation of extensive development work, due to the impossibility of ascertaining in advance just what rights will be acquired thereby. It may be said that this rule means an end to all future large pumping projects. If these projects are based on the depletion of surface waters, it is far more economical both in money and water, and thus better for the state as a whole, that those surface waters be utilized through surface developments, as they doubtless will be when necessity arises. If, on the other hand, they are based on the use of water which will not affect surface developments, past or future, there are other principles of law, not necessary for the determination in this case, which properly applied will do justice to the state and to its individual citizens alike. While it may be, and doubtless is, true that the effect of the declaration of public policy made by our legislaure so long ago will be to lessen somewhat the number and size of future irrigation projects depending upon pumped water, in our opinion it is more than compensated by the establishment of certainty and security for the vastly more important surface projects now existing and which will doubtless exist in the future.

Erosion Below Conowingo Dam Proves Value of Model Tests

Design based on results of tests made in Worcester laboratory found effective in minimizing erosion and in insuring that it occurs only at a safe distance below the dam

By L. N. Reeve
Hydraulic Engineer, Stone & Webster Engineering Corp., boston, Mass.

EXAMINATION of the riverbed below the Philadelphia Electric Co.'s Conowingo dam, on the Susquehanna River in Maryland, clearly indicates that the small-scale model tests made as part of the design studies had accurately predicted where and how erosion would develop below the dam. Further, the results obtained after three years of actual experience serve to emphasize the value of model studies in determining a design that will give maximum safety and economy.

The Conowingo plant is located on the Susquehanna River a few miles above tidewater and near the village of Conowingo, Md. The drainage area above the dam is about 28,000 square miles. The runoff from this area is largely unregulated; floods of 400,000 to 500,000 sec.-ft. are of common occurrence, and a flood of 750,000 sec.-ft. is on record. Because of these facts it was deemed advisable in making the design studies for the dam to provide for a flood of 880,000 sec.-ft. without raising the headwater level above that maintained for normal operation of the station. The reservoir above the dam has a surface area of about 9,000 acres and obviously is of insufficient size to have any material effect in reducing floodflows without raising the reservoir level beyond the narrow limits prescribed by local conditions.

A plan and typical cross-section of the dam are given in Fig. 1. As will be seen there, provision for handling floodwater is made in a spillway surmounted by 50 crest gates 22 ft. 6 in. high, and with a clear opening of 38 ft. The crest of the spillway is a parabola of the equation

$$X^2 = 2.22\,HY$$

where H is the maximum head on the crest—namely, 22 ft. 6 in. This depth of flow required the adoption of an overhanging crest to permit of economical design of the structure as a whole.

The gates are designed to be raised well above the flood level to give a free flow over the spillway. They are opened whenever the flow in the river exceeds that used by the seven turbines in the power house—or at 42,000 sec.-ft. Under these conditions the reservoir level will be about at El. 108.5, and the depth on the crest will be 22 ft. 6 in. With this depth on the crest, each gate discharges about 16,000 sec.-ft. The energy of this water that must be dissipated harmlessly below the dam is about 150,000 hp. for each gate opening.

The dam is built upon granite, sound but broken up by joints in all directions. Many of the joints were filled with clay, and it appeared obvious at the time the preliminary studies were made that erosion would develop at the toe of the dam unless provision were made for the dissipation of the energy of the floodwater.

An apron of the design adopted was provided opposite 40 of the 50 crest gates (Nos. 1 to 40, inclusive) and also opposite the three regulating gates at the south or power-house end of the spillway. No apron was built opposite gates Nos. 41 to 50 inclusive, at the north end of the dam, since this section of the spillway will be used only during floods of unusual magnitude and rare occurrence, under which condition there will probably be little erosion due to the high tailwater level. The bed of the river just below this latter section has been protected with concrete.

Model studies

As no method of predicting the extent and place of maximum erosion below the dam was found that would have value as a basis for a design to meet the particular conditions, it was felt that model

Fig. 1—Conowingo dam, showing location of spillway section and details of the adopted design.

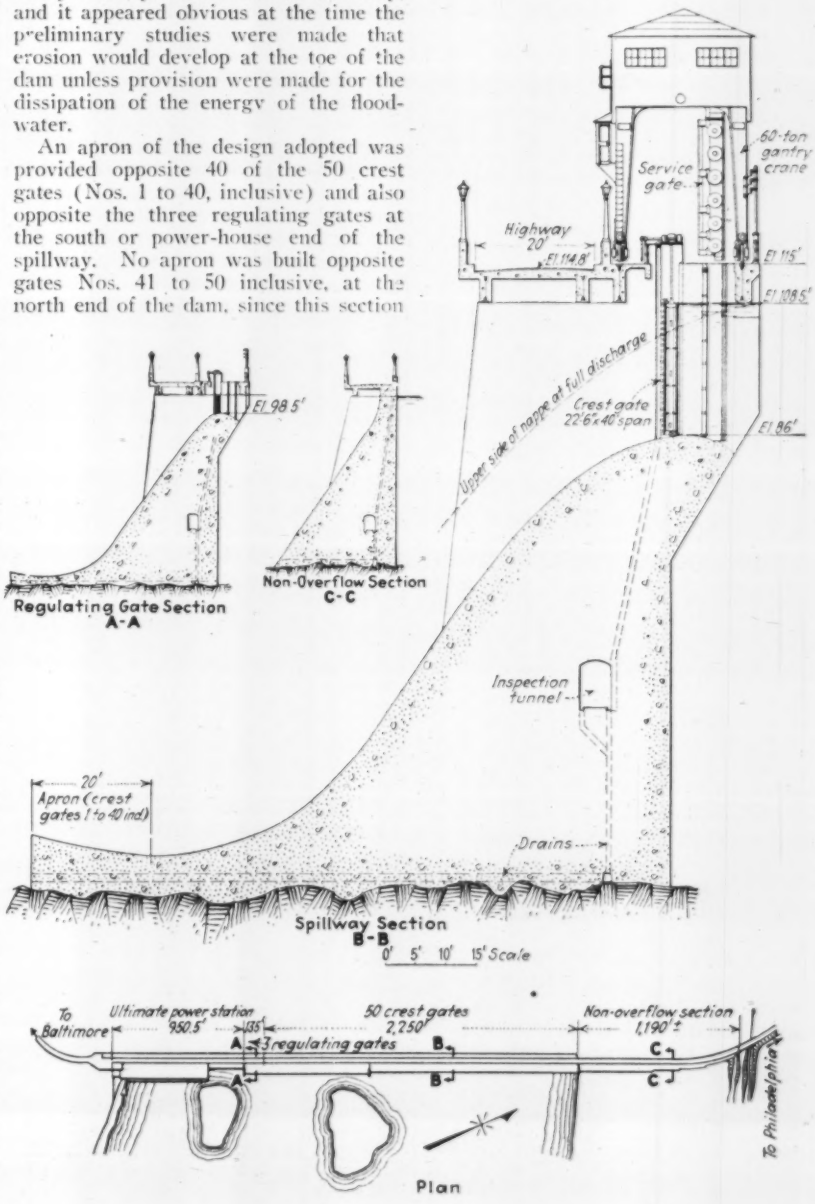


Fig. 2—Adopted spillway design under test in Alden laboratory. The large stones that may be seen through the glass side of the sluice in the foreground were used to simulate large blocks of granite found in the channel below the dam.

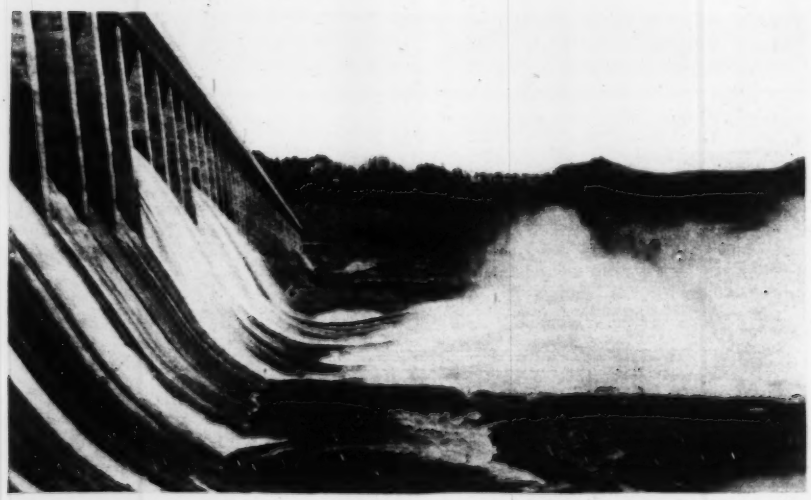
studies should be employed in determining the best type of apron for the dam. As a result, a series of model tests was undertaken at the Alden hydraulic laboratory of the Worcester Polytechnic Institute. The testing was done by engineers of Stone & Webster Engineering Corp., with the cooperation of Prof. C. M. Allen of the institute.

In deciding upon model testing as a means of solving the erosion problem, it was realized that that method would not necessarily eliminate all indeterminate factors. For this reason the model tests for Conowingo were conducted using models of a size that was believed sufficiently large to reduce the indeterminate factors to a minimum.

The model used in the test is shown in Fig. 2. It was constructed of wood to an exact one-thirtieth reproduction of the structure to be built. In order to obtain a smooth surface for the spillway, it was painted with several coats of white lacquer. As the gate piers were at 45-ft. centers, it was possible in the space available in the laboratory to construct two full-gate sections in the 3-ft. width of the testing sluice. One full-gate section was located in the middle of the sluice with a half-gate section at each side. This arrangement was considered best suited for observing conditions developing under varying conditions of gate opening. The details of this arrangement are shown in Fig. 2.

Fifty test runs were made, using different aprons and gate openings. The river bottom for most of the tests was simulated by crushed rock in pieces large enough to correspond correctly to the large blocks of granite lying in the natural riverbed. Actually, this small material was less stable proportionately than the rocks lying in the natural river bottom, but it was found that larger material would not move readily under the erosive action of the water and therefore failed to indicate properly the effect of changes in the design of the aprons under test. Also, this use of crushed rock in small sizes provided a margin of safety in predicting the maximum extent of the erosion that would actually take place. The need for being able to detect even a tendency to erode under varying arrangements of the apron becomes obvious when it is realized that, while the volume of water discharged over the model of the dam with two gate sections open produced 1½ hp. of energy to be dissipated in the test sluice, the corresponding energy to be dissipated under actual conditions amounts to 300,000 hp.

Fig. 3—Energy below the dam is dissipated in a hydraulic jump.



The principal arrangements of the model for the test studies are shown in Fig. 5. With no apron, but using the conventional bucket on the downstream slope of the spillway, the falling water created an eddy immediately downstream from the dam, which rapidly washed out the river bottom and undermined the toe of the dam. A modification of the bucket design, as shown in cases II and III, greatly reduced the tendency of this eddy to have destructive effects upon the river bottom. The 90 deg. bucket (case II) was on the whole the most effective of these two types, although the jet formed by the union of the two streams when alternate gates were opened caused considerable erosion at the toe of the dam. Analysis of these designs indicated that the construction and maintenance cost of either of the buckets would be high; also that if erosion did occur, it would be close enough to the dam to affect the stability of the structure.

Studies of the effect of the hydraulic jump as an effective means of dissipating the energy were begun with a level apron corresponding to an apron length of 200 ft. at El. 20, or about 4 ft. above the foundation. The radius of the

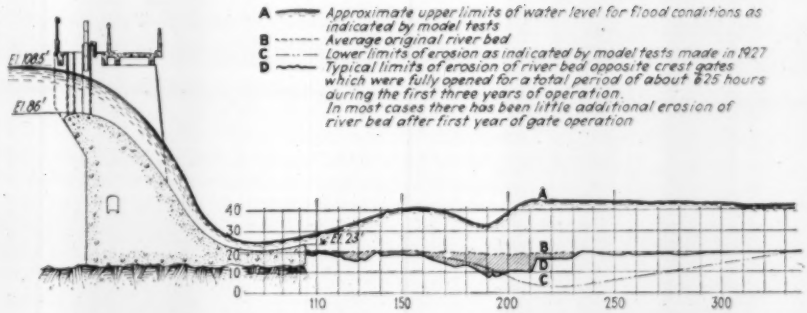

A — Approximate upper limits of water level for flood conditions as indicated by model tests
B — Average original river bed
C — Lower limits of erosion as indicated by model tests made in 1927
D — Typical limits of erosion of river bed opposite crest gates which were fully opened for a total period of about 825 hours during the first three years of operation.
In most cases there has been little additional erosion of river bed after first year of gate operation
El. 128.5'
El. 86'
El. 23'
40
30
20
10
0
110
150
200
250
300
A
B
C
D

Fig. 4—Erosion below the dam has developed as predicted in the model studies.

bucket was 40 ft. for this and for the remaining model tests. A depth of about 35 ft. of tailwater at El. 55 was required to produce the jump within the limits of the apron. No erosion took place below the apron with this tailwater level. With lower tailwater levels the water flowed along the apron with little reduction in velocity, and erosion took place at the end of the apron. As the tailwater level for ordinary flows would result in only about half the depth required to produce hydraulic jumps on the apron, it was obvious that a high weir would be required at the end of the apron to maintain the required depth of the tailwater to meet these conditions.

Tests with an apron length corresponding to 100 ft. gave results comparable to those obtained with the 200-ft. apron, and tests on a level apron 40 ft. long gave results little better than with no apron.

The addition of two rows of diamond-shaped baffle piers to the 40-ft.-level apron resulted in breaking up the sheet of water. The only change this made from the result obtained with the unobstructed apron, however, was to move the point of maximum erosion farther downstream.

The baffles used corresponded to piers 5 ft. high placed on 7-ft. centers in each row, the piers being staggered. While effective to some extent, the first cost and maintenance of such baffle piers was believed to be excessive for the conditions to be met at Conowingo.

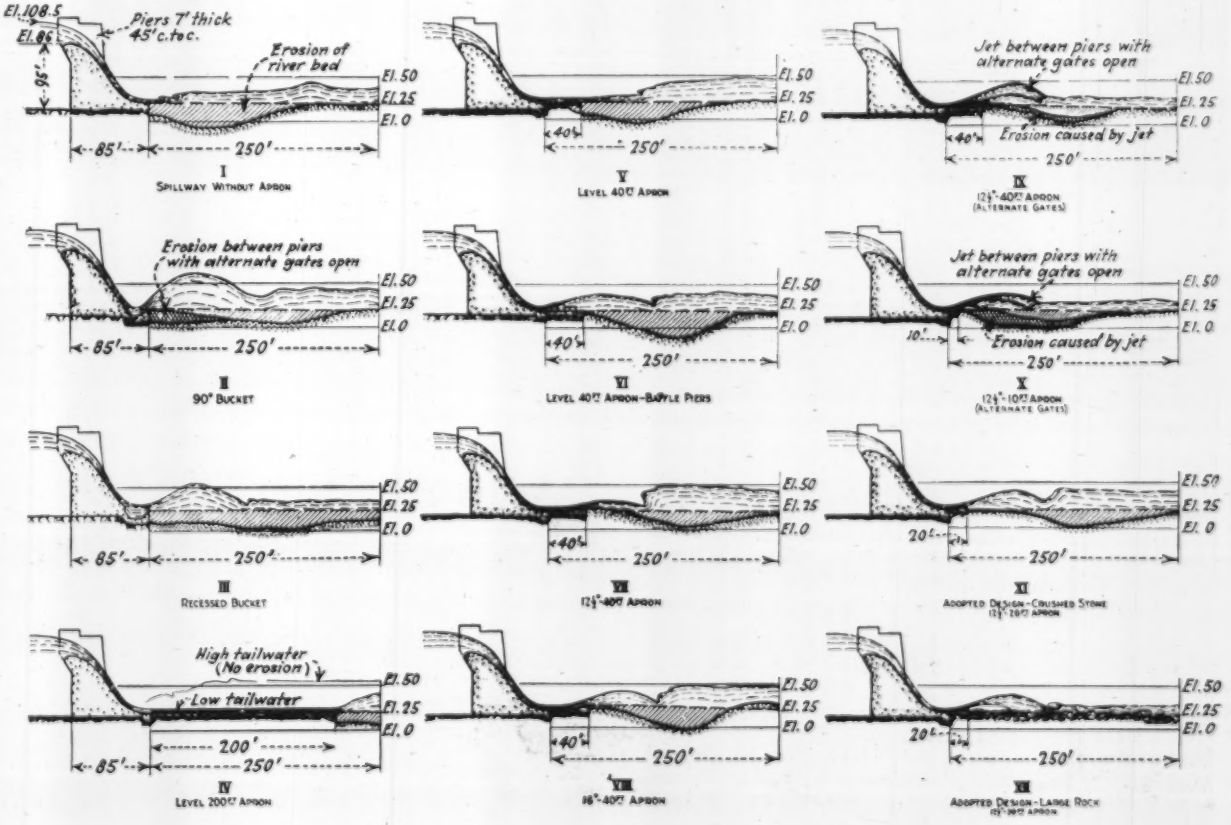
In the subsequent tests deflectors placed at varying angles with the horizontal were used at the end of the level 40-ft. apron. In these tests it was found that with a deflector placed at an angle of about 12½ deg. (case VII) the overfalling sheet was deflected so that no measurable erosion occurred within 60 ft. of the apron, and no appreciable eddy occurred at the downstream edge. Fine sand placed immediately downstream of the apron was undisturbed by the overflowing water.

A deflector 16 deg. with the horizontal (case VIII) produced some raveling of the riverbed at the downstream edge of the apron, and the erosion was not only deeper but took place nearer the apron than with a 12½-deg. deflector.

With the 40-ft. apron and the 12½-deg. deflector, and with the center gate on the model closed to simulate the effect of opening alternate gates, the total amount of erosion was much less than with all gates open. However, the erosion under the jet formed by the joining of the two streams was as much as with all gates open. Hence, there would be no advantage in operating the alternate gates. This jet did not develop with adjacent gates open. Its destructive action was increased with a reduction in the length of the apron, and, therefore, it became an important factor in determining the correct length of the apron.

When the apron length was reduced to 10 ft., retaining the 12½-deg. deflector (case X), erosion under the center jet was found to be more serious than with

Fig. 5—Progressive stages of model studies to determine best method of checking erosion below Conowingo Dam.



all gates open, the length of the apron remaining unchanged. Under conditions corresponding to the opening of every third gate, erosion at the toe was found to be negligible with any length of apron.

The best results in all clases were secured with the edge of the deflector terminating in a vertical downstream face.

Adopted design

The design of apron finally adopted (cases XI and XII) incorporated the 12½-deg. deflector, 20 ft. long, maintaining a smooth surface continuous with the 40-ft.-radius bucket of the spillway and terminating at a vertical downstream face. Tests indicated that this design would give protection equal to that for longer aprons with the same deflector, with either all gates or alternate gates open.

When testing the adopted design, using crushed stone to simulate the riverbed (case XI), it was found that erosion no longer continued after the riverbed had eroded to a depth of about 30 ft. When using large rock to simulate the riverbed (case XII) no erosion whatever took place, but upon removal of the deflector serious erosion occurred.

Prior to the model tests it was believed that an apron at least 40 ft. long with a deflecting surface at the lower end would be required. The tests showed no gain through the use of this apron and so resulted in considerable economy in the cost of building the dam.

Results support test deduction

An examination of the riverbed below the dam after three years of service shows the results indicated in Fig. 4.

Comparison of the actual conditions with the theoretical conditions indicates that the small-scale model studies were satisfactory in predicting what would happen below the dam. Except in one place the actual erosion has not exceeded the limit determined by the model tests. The exception occurred near the middle of the dam at a point where the bedrock is so free from seams and so well bonded together that it has successfully resisted erosion at the point where erosion was expected. This irregularity resulted in back currents and eddies and caused some erosion at the end of the apron. Recently, during a period of low water, the eroded rock was replaced with concrete, and no further erosion has developed.

The apron for gates 1 to 17, inclusive, was built at the time of the spillway, whereas the remaining section, from gates 18 to 40, was placed some months later and after floodwaters had been discharged over this section of the completed spillway. At the same time it was considered advisable to cover sections of loose rock and to fill in with concrete the cavities that had been eroded by these floodwaters immediately downstream from the apron, so as to prevent further erosion from eddy currents and other causes.

At the time this was done it was believed that the concrete below the apron might offer some additional protection from erosion, since water discharged from a single gate tends to spread over the apron opposite adjacent gates and hence does not behave at the jump in the same manner as opposite the gate through which it is discharged. To date, however, there is no positive evidence that this particular action has been responsible for any erosion opposite gates 1 to 17 in excess of that which might be reasonably expected from the model tests.

Stone & Webster Engineering Corp., as agent for The Susquehanna Power Co., a subsidiary of the Philadelphia Electric Co., handled the design and construction of the Conowingo dam and power house and associated with themselves in the construction work of the dam The Arundel Corp., of Baltimore. Daniel E. Moran, of New York, and Charles T. Main, Inc., of Boston, acted as special consultants on the foundations and structural design of both the dam and power house.

Depressed Apron Checks Erosion Below Hamilton Dam

Flexible mat on riverbed proves unsatisfactory — Energy dissipation now accomplished in pool over depressed apron

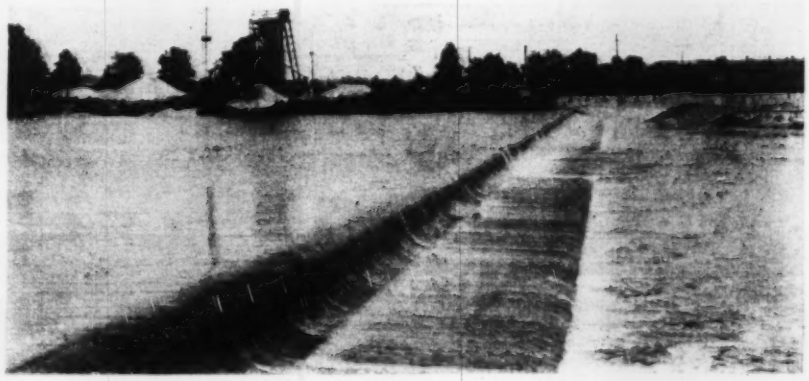
By C. H. Eiffert
Engineer, The Miami Conservancy District, Dayton, Ohio

FLOOD-CONTROL WORK carried out by the Miami Conservancy District at Hamilton, Ohio, consisted principally of deepening, widening and straightening the channel of the Great Miami River. One of the important factors in the maintenance of this channel has been a concrete overflow dam across the river at the upper end of the improvement. It prevents large amounts of sand and gravel from being carried into the improved channel. Two screening and washing plants immediately above this dam take out most of the gravel that accumulates and that in the absence of the dam would be carried into the channel below, where its removal would entail a considerable expense.

Typical sections of the dam as built are shown in Fig. 2. The length between abutments is 801 ft. The dam rests on a porous foundation consisting of a well-graded mixture of sand, gravel and boulders, with a few pockets of clay. It was built in the summer of 1922. As shown in Fig. 2, a flexible apron of concrete blocks was built downstream from the monolithic apron a distance of 42 ft. These blocks were the same as those used in the flexible revetment along the toes of the slopes in the improved channels. It was believed at the time that they would not completely prevent scour below the dam but that such scour, occurring at the downstream edge of the block apron, would cause it to settle into the depression until a state of equilibrium had been reached. After which no further scour would occur.

This scouring and settling of the

Fig. 1—The energy of the overflow sheet now is harmlessly dissipated in the pool over the apron extension.



apron took place as expected; however, the blocks proved to be too light. Apparently the action of the water during floods caused a vertical movement of the blocks, and repeated bending of the ½-in. cables due to this motion caused them to break at the edge of the solid apron. Repairs were made by pouring a layer of concrete over damaged portions of the block apron, this layer being bound into the blocks by removing some of them so that the cables would be embedded in the new concrete. This work did not prove satisfactory, and repairs were made in several places by dropping 18 and 24-in. cubes of concrete below the solid apron. This gave the dam a rather unsightly appearance in low water. It was also evident that the old block apron would continue to be a source of trouble until it had been entirely replaced.

In the deepest part of the river channel, for a width of 150 ft., the monolithic apron had been built 2 ft. lower than on the rest of the dam. Very little damage had been done to the flexible apron on this section, due to the fact that it was protected by a water cushion. It was therefore decided that, if the entire apron could be lowered in order to provide such a cushion, further damage could be prevented.

The writer has noted in the study of engineering literature concerning this type of dam that it has often been necessary to repair the aprons due to underscour, and that in practically all cases the method adopted has been to extend the apron downstream but not to lower it to any appreciable extent. The water, in passing over a smooth, slightly sloping or level apron, with no water standing upon it, loses very little of its velocity. The mere extension of an apron therefore does not prevent the scouring action but simply locates it farther from the main portion of the dam. If, however, the apron extends into water of considerable depth, the velocity of the overflowing sheet of water is lost in the standing wave as it enters the deeper pool and its destructive energy is dissipated.

In repairing the dam at Hamilton the apron was extended downstream a distance of 16 ft. and lowered 6 ft., as shown in Fig. 2. The under side of the concrete at its downstream edge is 8½ ft. lower than the top of the downstream edge of the original monolithic apron. In low water the water surface is from 2 to 3 ft. below the top of the original apron, thus giving a minimum depth of 3 to 4 ft. on the new apron.

In carrying out the work a small dragline excavator with a 35-ft. boom and ¾-yd. bucket, mounted on caterpillars, was used for breaking up the old concrete and for excavating. Breaking up the concrete was accomplished by pounding it with a heavy iron weight attached to the hoist cable of the dragline.

The work was done in sections varying from 50 to 200 ft. in length. Flashboards were first placed on the dam along the section to be excavated. The remains of the block apron were then broken up and the trench for the new concrete excavated, some of the material being used for a cofferdam. The bottom of this trench was about 6 ft. below water level, and a 6-in. gasoline-driven pump on wheels was used to unwater it. After the water had been pumped out the grading was finished by hand. Holes were drilled in the original solid apron, and ¾-in. bars 3 ft. long, 18 in. c. to c., were grouted into them to tie the new concrete to the old. An end form was built of rough lumber, and templets were placed to which the surface concrete could be finished. Concrete was discharged from a small mixer directly into the apron and was of such consistency that it could be finished on the desired 2 to 1 slope without top forms.

After the apron had been concreted the rest of the trench was backfilled by the dragline, principally with pieces of broken concrete and stones, and the surplus excavated material was graded to provide a reasonable degree of smoothness for the trench.

The work was done by force account, and the engineering and inspection was handled by the district's regular force.

The quantities involved were 1,000 cu.yd. of concrete and 3,040 cu.yd. of excavation, about 600 cu.yd. of the latter being the old concrete. The costs, not including engineering and inspection, were as follows: labor for hand grading, pumping and concreting, $2,261; concrete and forms, $5,482; drilling, $282; miscellaneous, $235, or a unit cost per yard of concrete placed of $8.26. Dragline rental amounted to $1,780; pump rental, $249; and miscellaneous expenses for the excavation and backfilling were $100.

Seepage under the dam

During the progress of the work careful observations were made as to seepage through the gravel under the dam. At only two points was any such seepage in evidence, and in each case it consisted of a very small stream. Nevertheless, drain pipes were placed through the new concrete at intervals of about 20 ft., midway between top and bottom, to relieve any possible upward pressure.

As the dam is founded on porous material a study was made to determine the safe limits for seepage. W. G. Bligh, who has had much experience with dams on porous foundations, in his book "The Practical Design of Irrigation Works," developed a coefficient of seepage or percolation for such dams that should not be exceeded if the dam

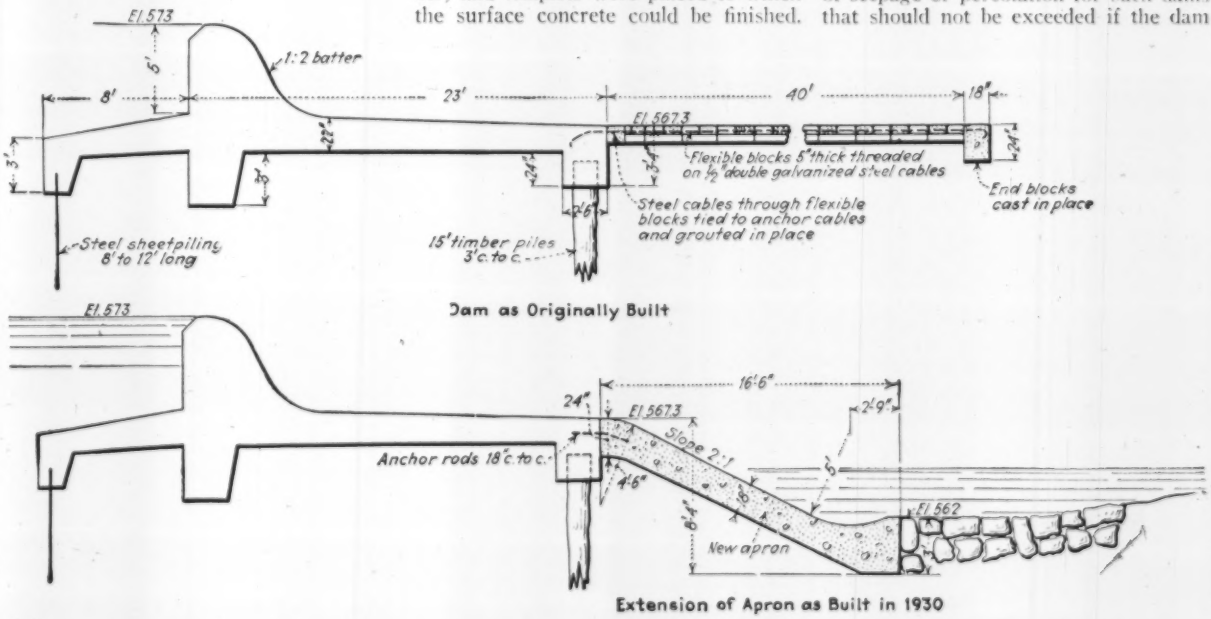


Fig. 2—Flexible mat below Hamilton dam replaced by a depressed extension of the apron.

is to be safe against piping or underscouring by such percolation. This coefficient c is equal to $\frac{l}{h}$, where l is the length of enforced percolation and h is the head between the water level above the dam and the tailwater. From his experience with this type of dam and from records of failures Mr. Bligh determined the values of c for various foundation conditions as shown in the accompanying table.

The material at the Hamilton dam would fall in class IV. As actually constructed, the value of c for the dam was about 10. Later the streambed below the dam was eroded somewhat, lowering the low-water level and reducing c to about 8.5. By the extension of the apron this figure has again been increased to about 10.

COEFFICIENTS OF SEEPAGE UNDER DAMS

	Class	Coefficient
River beds of light silt and mud, as the Nile	I	18
Fine micaceous sand, as in Himalaya rivers and the Colorado in the U.S.A.	II	15
Coarse-grained sands, as in Central and South India	III	12
Boulders or shingle and gravel and sand mixed	IV	9 to 5

Cross Method Applied to Secondary Stresses

Analysis of 150-ft. truss completed in six hours by determining fixed-end moments from Williot diagram displacements and adjusting these moments by method of Prof. Hardy Cross

By Francis P. Witmer
Director of Civil Engineering, University of Pennsylvania, Philadelphia, Pa.

THE METHOD of analysis by distributing end moments, recently proposed by Prof. Hardy Cross (*Proceedings*, Am.Soc.C.E., May, 1930) is readily applicable to the solution of secondary stresses in trusses, and the writer believes that it will prove the simplest and most expeditious method yet advanced for this purpose.

The writer applied this method to the 150-ft. six-panel Warren truss considered by C. V. von Abo in his paper "Secondary Stresses in Bridges" (*Transactions*, Am.Soc.C.E., September, 1924). Mr. von Abo analyzed the secondary stresses in this truss by several different methods. The results by the Cross method closely approximate those of Mr. von Abo and can be obtained in about six hours of working time, which does not seem possible of accomplishment by any of the other methods considered.

Briefly, the procedure was as follows: after the stresses and distortions in the truss members for the loading assumed (see Figs. 2A and 4) had been computed, a tentative Williot diagram (Fig. 2) was constructed, assuming the middle hanger to remain vertical. This diagram showed that the truss would rotate counterclockwise, so that the right end would rise to a point higher than the left end by the distance A = 0.000755 in., as shown in Fig. 2A.

A corrected Williot diagram was next constructed (Fig. 3), assuming member 6-7 to be in the position that it would assume if the truss were rotated clockwise so as to keep 12 at the same level as 1. This would move 6 to the right with reference to 7 by an amount 6-7 equal to $0.000755 \times 31/150 = 0.000156$ in., and Fig. 3 was therefore constructed by assuming 6 and 7 as shown, 0.000156 in. apart horizontally, instead of coincident, as in Fig. 2.

Fig. 3A shows all joints in their final deflected locations as determined from Fig. 3, but the curves shown for the various members are not the final elastic curves but are drawn to show the curvature that would exist if all joints were fixed against rotation.

In Fig. 3 it is obviously true that any distance, as 1-1, perpendicular to the direction of the member 1-2, will equal the displacement of one end of this member, 2, with respect to the other end, 1, in such perpendicular direction. In other words, it will represent the relative positions of the ends of the member if it is assumed to have *fixed-end moments*, the starting point for all analyses by the method of Professor Cross. The displacement just described will equal the sum of the deflections of the two part lengths of the member, due to their action as cantilever beams fixed at the ends of the member, and each deflected by a force V equal to the shear in the member, applied at the point of contraflexure (Fig. 1).

It is thus easy to express all fixed-end moments in terms of these displacements and the lengths (l) and moments of inertia (I), of the members. Thus, if D denotes the total displacement of one end of any member with respect to its other end (as given by Fig. 3), we have, for constant I and contraflecture at center (see Fig. 1),

$$D = \frac{2V}{3EI}\left(\frac{l}{2}\right)^3$$

SECONDARY STRESSES BY APPLICATION OF CROSS METHOD COMPARED WITH VON ABO'S RESULTS

(For six-panel truss 150 ft. long and 31 ft. deep, loaded with 1,500 lb. at panel point *G*)

Joint	Member	Direct Stress Lb./Sq.In.	Secondary Stress (Cross) Moment In.-Lb.	Secondary Stress (Cross) Fiber Stress Lb./Sq.In.	Secondary Stress (Von Abo) Manderla-Gauss Moment	Secondary Stress (Von Abo) Fiber Stress Range Omitting Mao's Method
1	1-2	—12.99	+113	0.41	+113	0.41— 0.42
	1-3	+15.23	—113	1.13	—113	1.12— 1.16
2	2-4	18.61	—343	1.36	—352	1.35— 1.43
	2-5	+21.83	+135	1.26	+134	1.25— 1.26
	2-3	0.0	+57	2.67	+62	2.88— 2.90
	2-1	—12.99	+151	0.55	+156	0.56— 0.58
3	3-1	+15.23	—13	0.13	—17	0.16— 0.25
	3-2	0.0	+64	2.99	+71	3.31— 3.33
	3-5	+15.23	—52	0.52	—54	0.53— 0.58
4	4-6	—18.61	+485	1.92	+490	1.83— 1.99
	4-5	0.0	+46	3.38	+44	3.16— 3.22
	4-2	—18.61	—531	2.10	—533	2.05— 2.22
5	5-3	+15.23	—282	2.82	—283	2.82— 2.89
	5-2	+21.83	+34	0.32	+31	0.28— 0.30
	5-4	0.0	+37	2.72	+36	2.64— 2.70
	5-6	—19.85	+235	2.05	+238	2.07— 2.09
	5-7	+24.02	—24	0.17	—23	0.15— 0.22
6	6-8	—37.22	—580	2.29	—584	2.26— 2.37
	6-9	+19.85	+208	1.81	+206	1.77— 1.80
	6-7	0.0	+97	4.54	+98	4.60— 4.62
	6-5	—19.85	+210	1.83	+212	1.84— 1.86
	6-4	—18.61	+65	0.26	+68	0.24— 0.31
7	7-5	+24.02	—45	0.31	—44	0.29— 0.32
	7-6	0.0	+100	4.68	+101	4.72— 4.74
	7-9	+24.02	—55	0.38	—57	0.39— 0.43
8	8-10	—37.22	+2,694	10.66	+2,688	10.52—10.82
	8-9	0.0	—26	1.91	—25	1.82— 1.88
	8-6	—37.22	—2,688	10.55	—2,663	10.41—10.72
9	9-7	+24.02	—882	6.15	—882	6.14— 6.21
	9-6	+19.85	—193	1.68	—192	1.62— 1.71
	9-8	0.0	—18	1.32	—18	1.29— 1.33
	9-10	+43.67	+159	1.48	+158	1.44— 1.49
	9-11	+30.46	+934	9.34	+933	9.29— 9.48
10	10-12	—25.98	—658	2.38	—643	2.30— 2.48
	10-11	0.0	—152	7.11	—154	7.19— 7.29
	10-9	+43.67	—252	2.35	—256	2.32— 2.42
	10-8	—37.22	+1,062	4.20	+1,053	4.12— 4.36
11	11-9	+30.46	+204	2.04	+205	1.94— 2.07
	11-10	0.0	—163	7.63	—167	7.82— 7.89
	11-12	+30.46	—41	0.41	—38	0.26— 0.40
12	12-11	+30.46	+254	2.54	+254	2.54— 2.64
	12-10	—25.98	—254	0.92	—254	0.91— 0.96

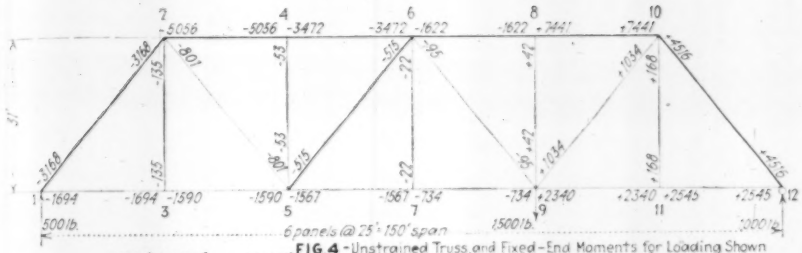


FIG. 4 - Unstrained Truss, and Fixed-End Moments for Loading Shown

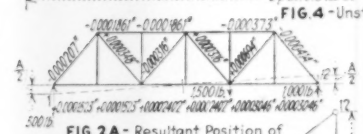


FIG. 2A - Resultant Position of Truss for Displacements of Fig. 2

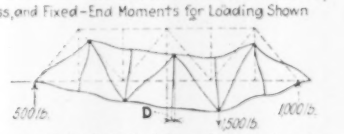


FIG. 3A - Deflected Truss, Corresponding to Displacements of Fig. 3, but with Ends of Members Fixed

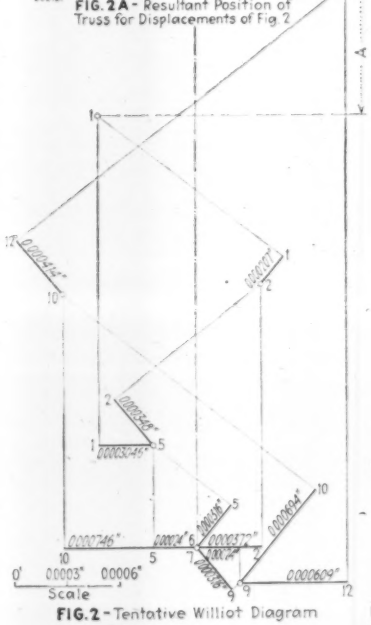


FIG. 2 - Tentative Williot Diagram

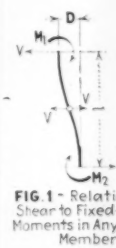


FIG. 1 - Relation of Shear to Fixed-End Moments in Any Truss Member

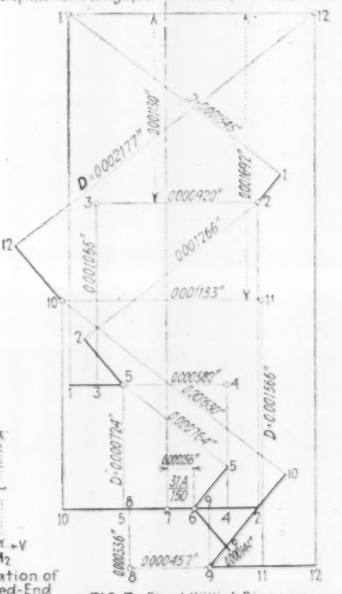


FIG. 3 - Final Williot Diagram

Outlines of 150-ft. truss in unstressed and stressed conditions, with tentative and final Williot diagrams.

$$\text{Where } V = \frac{M_1 + M_2}{l}$$

But, as for fixed ends $M_1 = M_2 = M$, we have

$$D = \frac{2}{3EI}\,\frac{2M}{l}\left(\frac{l}{2}\right)^2 = \frac{Ml^2}{6EI}$$

$$\text{whence } M = \frac{6EID}{l^2}$$

By this equation the fixed-end moments M throughout the truss were computed. When written in their proper places at the ends of the members (Fig. 4, clockwise moments positive), they formed the starting point of the procedure of distribution and carrying over as described by Professor Cross. This procedure was continued until the quantities involved became negligible, when a summing up of the moments at each end of each member gave the final secondary bending moment at that point.

If errors in the work of solution are discovered after the analysis has been completed, they may be allowed for by setting down at the proper points the quantities necessary to correct the discovered errors, carrying through the process of Professor Cross's method for *these quantities alone*, and finally combining the resulting moments with the erroneous ones first computed, in order to obtain the corrected moments. This condition will exist in all solutions by the method of Professor Cross.

Herewith are tabulated the final secondary moments and extreme-fiber stresses obtained in the foregoing analysis, with the results of Mr. von Abo for comparison. In the case of members with coverplates, an average distance c to extreme fiber was used for the sake of simplicity, the difference in resulting fiber stress being very small. The fiber stresses by Mao's methods were ignored in the comparison, as these were manifestly less accurate than the other methods and were considered by Mr. von Abo to be very unsatisfactory.

In the foregoing study the writer was ably assisted by H. H. Bonner and M. P. Boutourlinsky, graduate students in civil engineering at the University of Pennsylvania.

Motor Roads in China

CHINA in 1921 had less than 100 miles of road suitable for motor car traffic. Now, ten years later, there are 30,000 miles of road usable during the greater part of the year. The progress in road construction in these ten years leads to the belief that within five years motor highway construction will greatly exceed new railway development and will furnish the country with a system of transportation which the laying of rails could not hope to accomplish for many years to come.

The roadbuilding programs carried out under the direction of the American Red Cross to alleviate famine-stricken districts in 1920 were a great impetus for modern roads. From 1923 to 1928 the international relief commission was responsible for the expenditure of several million dollars on the construction of dikes and roads. At present the various provinces are carrying out independently planned programs, using Chinese engineers exclusively, but the programs have been developed in a sporadic manner.

About 90 per cent of China's modern road mileage is of simple earth construction. Very little gravel or macadam construction has been done. In the country districts the work is usually done by conscripted labor, and the farmers impressed for this work are given only their food or its equivalent in cash, equal to about 8c. to 10c. per day in United States money. The usual method of construction, exclusive of that in foreign settlements or concessions, is to cut or fill to the level of the proposed road, which is sometimes then rolled by hand by a man or power roller but is usually left to traffic for compression. Very little equipment is used on country road construction, practically everything being done by hand labor. In the cities steam and motor rollers are used to some extent.

In the cities the streets are usually constructed of a broken stone foundation and a gravel or crushed stone macadam surface. The streets of heaviest traffic are sometimes paved with sheet asphalt, asphaltic concrete or by the asphalt penetration method, but the greater area receives only an asphalt surface treatment. The use of concrete has been practically negligible except in one or two instances for experimental purposes at the larger treaty ports. Native cement has been used to some extent but has not proved satisfactory for heavy traffic.

Construction Revival Is Essential to Prosperity

Industrial and business activity is shown to depend on building—Reduction of construction costs and study of new building needs and their economic value are proposed as the most direct means for restoring normal business

By Sanford E. Thompson

President, Thompson & Lichtner Co., Engineers, Boston, Mass.

SHARPLY DIFFERENT opinions are held on whether business leads building or building leads business. The economic events of the last ten years as presented by Mr. Thompson indicate that building has been the leader, down as well as up. He therefore challenges the building industry to act for a revival of construction. Three lines of advance are indicated: (1) to locate the most urgent needs for new building; (2) to prove that this new construction will return a profit; (3) and not least important, to devise new materials and methods of construction that will bring down the cost of building. —EDITOR.

FEW APPRECIATE fully the intensity of the present crisis in the building industries and its direct effect on the nation's industrial health. Construction of new buildings, roads and bridges, as well as maintenance and repair, constitute so large a portion of our total national business that the achievement of a normal degree of industrial activity seems impossible as long as construction remains in its present depressed state. Return to prosperity awaits the revival of construction activity. It is therefore essential that the facts be considered and ways found to bring about this revival.

Building and business

The facts of the relationship between building and business are of first importance. Of the 70 or 80 billions of dollars of annual business returns in the United States, some 8 to 12 billions normally go into construction. This is 10 to 15 per cent of the total and exerts a profound influence on the remainder.

About half of the huge construction expenditure is paid out for materials and equipment, the direct products of industry. When construction is heavily reduced, as now, industry suffers proportionately. It is therefore not hard to see why, with construction depressed, the Federal Reserve Board data should show a drop in manufacturing more than twice as large as the reduction in retail sales—40 per cent against less than 20 per cent. The effect of the reduced earnings of hundreds of thousands of building mechanics throughout the country, who normally contribute to general trade and industry, must also be kept in mind.

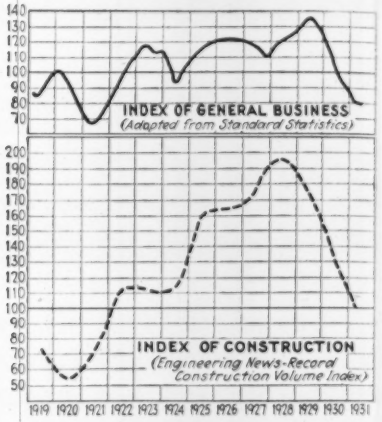
Precise figures to show the relation between construction and business are not available. Even a rough comparison, however, reveals significant facts. Such a comparison is given by the accompanying chart, which contains index curves of general industrial production and construction volume. It shows a sharp rise in the volume of construction during 1921, while the curve of general business was still falling—construction serving as a stabilizing factor in overcoming the depressed conditions of the summer of 1921. In 1924, despite slackening business, the curve of construction activity turns upward into a tremendous building boom. In 1928 the boom breaks sharply, while general business continues to move upward into its "new era" boom, which ended in the resounding crash of 1929. Throughout the boom, construction was falling off, steadily withdrawing its supporting orders from industry.

The position of construction in the van of business progress is clearly apparent. Today construction is relatively far more depressed than general business. Despite a large decrease in 1930, the reports for 1931 show the volume of construction to be more than 35 per cent below the volume of 1930. Evidently, one of the weakest points in our national industrial structure is the construction industry, and return to industrial normalcy must be largely dependent on its revival.

Are we overbuilt?

What are the prospects for a revival of construction activity? In our largest urban centers, hotels and apartments are built in excess of demand. A recent survey of existing office buildings by the National Association of Building Owners and Managers showed vacancies of nearly 20 per cent. The construction programs of the public utilities and the railroads are being curtailed to protect capital surplus, and the expenditures of our municipal and state governments are being drastically reduced. Federal public-works construction provides the only measure of relief.

But if the large cities are overbuilt, how about the smaller cities and towns? Certain classes of dwellings are considerably in excess of demand, but what of the available supply of other types of houses? The majority of our urban populations live in crowded unsanitary slum districts where there is a crying need for better housing. Where, in short, are the points of need throughout the country for new facilities to be filled by the construction industries? Only a careful investigation to determine the facts and their economic possibilities can furnish the answer to the problem.


INDEX OF GENERAL BUSINESS
(Adapted from Standard Statistics)
INDEX OF CONSTRUCTION
(Engineering News-Record Construction Volume Index)
1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931

Construction compared with industrial production. The upper curve (Standard Statistics Co.) is the index of industrial production, computed from 60 manufacturing industries and corrected for seasonal variation. Below it is plotted *Engineering News-Record's* index of construction volume, the dollar value of total construction divided by the construction cost index.

Thorough study needed

Thus, the construction industries are face to face with a problem that can be solved only through the engineering approach. The need for new construction must be determined by factual research. In addition, there is also the tremendously important problem of the improvement of existing methods of construction and the products of the construction industries.

Any manufacturer faced with the problem of falling sales must look into the suitability of his product, devising improvements in product and production. Especially home-construction methods are backward when compared with modern industrial methods. Were the price of sound, well-designed and constructed homes cut in half through new methods of construction and the wringing out of the water added to real estate transactions—and such a price reduction is by no means beyond the realm of possibility—there would be unquestionably an increase in the volume of home construction.

Improved methods and lower costs demand extensive research in all phases of the construction industry and especially in the low-price dwelling field. A walk through the slums and streets of moderate means anywhere shows great numbers of dilapidated and ancient

structures. A report to the President's conference on home building and home ownership by the committee on large-scale operations recently stated that: "The results of careful research . . . . have established the fact that practically no new dwellings, and certainly no desirable types of houses, have been constructed in recent years within the means of two-thirds of our population." The demand is obvious, but it is doubtful if the present methods of house construction can erect a desirable house within the means of the majority of our population. Research is imperative if the construction industry is to rise to its present emergency.

The performance of the necessary research work and the preparation of a suitable plan of operation is beyond the capacities of the usual committee, and any investigation of this sort is inadequate for the emergency. The situation should be met by the scientific method and solved through the intelligent marshaling of the forces of private enterprise for a thorough nation-wide survey of the situation and prospects in the construction industries, made by specialists who are capable not only of locating opportunities but also of determining their economic value. The problem is to put the available capital to work where it can receive a return perhaps small in percentage but emphatically of normal safety.

And the significance of the proposition is perhaps even more far-reaching than this presentation would indicate. It is being recognized by our leading minds that the one action that can relieve the business depression is the transfer of money that is now relatively dormant to the people who want to buy. The withdrawal of funds from savings banks and similar institutions, or from hoarding, and the borrowing of money to put into the construction of new dwellings and other types of construction will be of great economic value. It will pay the wages of those who in turn will buy goods and will create an additional demand for structural materials. It will help us win back prosperity.

Jetted-Casing Method Employed for Caisson Excavation

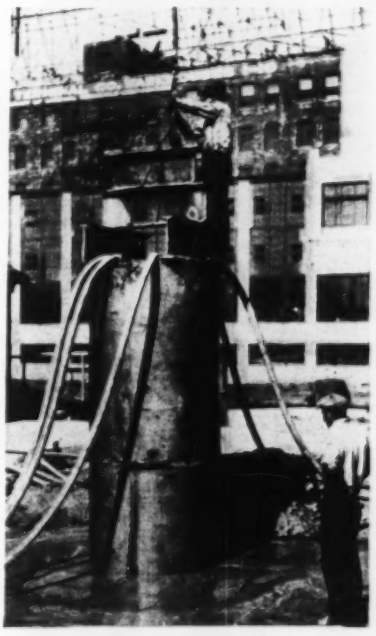
EXCAVATION for concrete foundation caissons through a thick layer of fine water-bearing sand has been greatly facilitated by the use of a thin-plate steel casing sunk to the underlying clay by means of water jets in constructing the substructure of the new outer-drive viaduct between the Michigan Canal and Chicago River in Chicago, Ill. The casings are made of 10-gage steel plate, butt-welded with butt straps on the inside, and are left in place to serve as forms for the caisson concrete.

In constructing the viaduct substructure it is necessary to sink 73 caissons to solid rock, 100 ft. beneath the ground surface. At a depth of 26 ft. there appears the characteristic Chicago blue clay, whose excavation is comparatively simple. Overlying the clay, however, there is a layer of fine sand, most of which is below lake level and saturated with water. Excavation of the sand proved extremely difficult and expensive when using the customary expedients.

The jetted-casing method of shoring the excavation was devised by the caisson contractor, the Al. Johnson Construction Co., of Minneapolis. An application for a patent has been filed.

The steel shells as constructed are 30 ft. long (long enough to be sealed into the underlying clay 4 ft.) and are of such diameter as to be equal to the finished caisson concrete, varying from 4 to 6 ft. Longitudinal and girth joints both are butt-welded with inside butt straps contributing to the rigidity of the shell. Six 2-in. water pipes for the 4- and 4½-ft. caissons and eight for the larger caissons, spaced equally, are carried down the inside of the shell and terminate in ½-in. jets. Each pipe carries one jet directed downward in line with the inside face of the shell and, by means of a short tee and elbow, another jet of equal size is directed upward along the outside surface. Small holes drilled into the sides of the elbow also provide minor jets directed horizontally.

Jetting steel casing through water-bearing sand to a stratum of tight blue clay.



Jet pipes in place, showing double nozzles pointing down inside and up outside.

The first 8 ft. of the hole is excavated by hand and braced with timber. The steel shell is then set in place and the jet pipes are connected with a motor-driven centrifugal pump that supplies 1,200 gal. per minute to the jets under a pressure of 100 lb. per sq.in. The sand is loosened and displaced by the water and rises to the surface outside the casing. Only 10 min. is required to carry the casing to clay if the sinking is uninterrupted. A driving head of four 15-in. I-beams is attached to the top of the casing, and it is driven into the clay with a steam hammer. After the casing has been seated in the clay the water in the hole is pumped out and the sand and clay are excavated by hand and removed in buckets.

The excavation through the clay is carried on by the Chicago well method, using vertical wood logging supported by steel rings. After the underlying rock has been reached the entire hole and casing are filled with concrete.

The outer drive improvement is being constructed by the South Park and Lincoln Park commissioners under the direction of Hugh E. Young, consulting engineer for both park boards, who is also chief engineer for the Chicago Plan Commission and made the original engineering plans for the entire improvement for the park boards. Harry Bernstein, engineer of bridge construction, is in local charge. The general contractor is The Kettler-Elliott Co., of Chicago.

Montreal Laundry Erects a Windowless Building

A new extension to Toilet Laundries, Ltd., in Montreal, Canada, is nearing completion and will represent the first windowless structure of modern design in Canada, according to an item published in *The Canadian Engineer*, Nov. 17, 1931. In the building will be installed equipment for complete purified air control and for controlled air temperature at 68 to 70 deg.

Civil Engineers Meeting at New York Well Attended

Remarkable interest, for the times, shown at the 79th annual meeting—Seven technical divisions hold separate sessions—Honorary membership conferred on four members

Engineering News-Record Staff Report

AN UNUSUALLY LARGE attendance, considering general business conditions, was recorded at the 79th annual meeting of the American Society of Civil Engineers held in New York from Jan. 20-23. The meeting opened with a general session for the reports of officers and committees and for the conferring of honorary membership, medals and prizes.

A healthy state of affairs in the society was reported by the secretary, George T. Seabury. Losses through resignation or being dropped from the rolls have been small, and the society made a net gain in membership of 531. Finances also are in sound condition. Early in December, at the low point in the year in the matter of society income, the treasurer had to borrow $20,000 to meet current expenses, but that loan was paid off before the end of the month.

Three standing committees submitted brief reports. Lazarus White reported that the committee on earths and foundations had two studies in progress, one at Massachusetts Institute of Technology under the direction of Prof. G. Gilboy, and one at the Technisch Hochschule at Vienna under Dr. Charles Terzaghi. A paper on foundation pressures by Professor Gilboy is now out for comment. At Vienna Dr. Terzaghi is conducting tests on tanks founded on yielding clays.

D. C. Henny, chairman, and J. C. Stevens, secretary, both spoke for the committee on irrigation hydraulics. The committee's glossary of hydraulic terms, to which the committee has devoted a great deal of time, is now ready for publication.

A report for the committee on salaries was presented by the chairman, E. P. Goodrich. Mr. Goodrich stated that the committee's present interest was centered in plans for the relief of unemployed engineers. Its studies on salaries is more complete for the higher grades than for the lower ones, hence future studies are to be directed toward collecting adequate data concerning the status of men in the lower grades. The committee, working through local groups, hopes to check the cutting of salaries in these latter grades.

Bridge clearances over navigable channels was the first subject to be discussed at the opening technical section meeting, that of the engineering economics division, the youngest of the society's divisions. In the absence of Ralph Budd, chairman, A. J. Hammond presided.

Two brief papers were presented for discussion, one on the vertical clearance required at bridges below seaports, by C. E. Grunsky, San Francisco, and one on the legal and economic phases of bridge-clearance requirements, by Walter H. Wheeler, of Minneapolis. Mr. Grunsky made an ardent plea for the setting up of an international standard for vertical clearances at bridges below seaports. Mr. Grunsky stated that since the time that he served as a reporter on bridge clearances for the International Association of Navigation Congresses in 1912, he had endeavored to get the association to take up the subject of setting such a standard, but so far without success.

Mr. Wheeler put before the society a group of questions on the economics of bridge clearances that he believes it might well take up, namely: Do we need or will there be future need for the clearances now required by federal authorities? Is the tax burden they bring justified when such bridges are over streams not now used for commerce? Would it be sounder economics to provide clearances for modern tows and barges and require old-fashioned boats to modernize to conform to them? Shall we require long spans or substitute short spans with channel piers protected by fenders? What are the legal rights of the parties, and is corrective legislation needed? How do clearances here compare with those in foreign countries? What are the military aspects of the problem?

Mr. Wheeler believes that the federal act of 1906, under which the chief of engineers now has to approve of bridge clearances, should be amended to require that the War Department also make a determination of whether the boats using the channel under consideration are not too large for the purpose.

In discussion it was suggested by Jonathan Jones, Pittsburgh, that amending the act of 1906 to require that the secretary of war make a determination as to the effect of the burden of high clearances on land traffic in relation to the burden placed on water traffic by low clearances would go a long way toward solving the present difficulties.

Utility Valuation—A notable addition to the fundamental data on utility valuation compiled by the society some years ago (*Transactions*, Am. Soc. C.E., Vol. 81, 1917, p. 1311) was made by E. B. Black, consulting engineer of Kansas City, in a paper on the present status of valuation procedure. Mr. Black made the pertinent comment that, so long as the profession sanctions such wide differences as now appear in valuations made by engineers for opposite sides in a valuation controversy, just so long may it expect to have the credibility of the testimony of engineers questioned. Engineers, he stated, should appear as friends of the court, not as advocates for either side. He believes that the economics division should impress this point upon the society membership. Mr. Black's paper summarized the principal court decisions bearing on valuation cases, methods of determining unit prices and value of lands, overhead costs, cost of financing, depreciation and going value.

Discussion centered chiefly around depreciation and going-concern value. Prof. H. E. Riggs, University of Michigan, stated that most controversies now center around four subjects not yet settled by the courts: weight to be accorded to cost of reproduction, depreciation, going-concern value, and overhead in determining the value of a utility. C. E. Grunsky stated that what is commonly accepted as the value of a utility cannot be used as a rate base because it includes going-concern value and depreciation. A rate base, he stated, should be the legitimate investment in the property in terms of dollars *at the time of valuation*.

Long-range planning

The work of the federal employment stabilization board was outlined to the engineering economics division by D. H. Sawyer, director of the board. In brief, he stated, the work of the board is directed toward laying down a six-year planning program for the federal government, collecting economic data and statistics of construction, and helping states and cities to work out long-range construction plans like those the board is laying down for the federal government. The city of Washington, he said, is to be used as a sort of laboratory for the latter work.

Highway division

Two subjects were discussed at the highway division meeting: the New Jersey approaches to the George Washington Bridge, and unemployment relief studies being made in St. Paul and Minneapolis. J. L. Bauer, state highway engineer of New Jersey, described the costly work of integrating the traffic to and from New York City over the new bridge with the existing traffic

at the New Jersey end, without seriously interfering with the dense traffic on the highways parallel with the river. This system of approach roads was described in our issue of Oct. 22, 1931, p. 662; the description need not be repeated here. However, one point stressed by Mr. Bauer was not noted there—namely, the unjustifiable tax that is put on the public in paying for right-of-way for this and like new highway work by present methods of condemnation.

Discussion of Mr. Bauer's paper centered chiefly around the dry concrete specified for pavements by the highway department, so dry that truck mixing does not work out successfully. R. W. Crum, highway research board, stated that studies of the Bureau of Public Roads had shown that extremely dry mixes tended to segregation and to honeycomb, that workability was a factor to be considered in addition to strength and that the bureau now favored a concrete giving a slump of 2 to 3 in.

Unemployment Relief—The subject of unemployment relief planning was presented by William N. Carey, chief engineer, department of public works in St. Paul. His paper did not describe the present emergency relief measures employed in the Twin Cities, as they had been described in detail at the St. Paul meeting of the society, but rather the work of the University of Minnesota Unemployment Research Institute, a body financed in part by the state and in part by the Rockefeller and like foundations. The institute began its work about six years ago. It has conducted an intensive research into the extent and character of unemployment, suitability of work, limitations of the unemployed due to training or physical conditions, and what might be termed the state of obsolescence of the industries studied. It has directed its study chiefly to three cities of the state. So far it has been unable to make deductions from its studies as to causes of depression and unemployment.

Sanitary engineering division

Two committee reports and one paper, each comprehensive, followed by a discussion of the three, made up the program of the sanitary engineering division. A small amount of business was transacted. The committee on progress and status of the art of sanitary engineering, through Langdon Pearse, Chicago, reviewed in considerable detail the advances in water supply and sewerage, including treatment and interstate litigation. Under garbage and refuse disposal the report outlined last year's experience with incinerator bids at Washington, D. C., first under limited, then free-for-all bidding, and to the successful outcome of the New Jersey litigation to prevent dumping at sea of garbage and rubbish of New York City. The other committee report was a summary of two years' work of the committee on sludge digestion, headed by Samuel A. Greeley, Chicago. The one paper heard at the session was on the activated-sludge process, by Wellington Donaldson, of Fuller & McClintock, New York City.

The report of the committee on sludge digestion was a printed summary of a lengthy report in ten chapters now ready for final editing.

Activated-Sludge Process—Mr. Donaldson, in his paper, stated the case for large and for small plants thus:

1. For large projects this process is assuming a more dominant position where it is important to provide so-called complete treatment. It is readily feasible to supplement this process by chlorination or filtration, or both, if necessary.

2. For small plants this process has a less favorable status than a few years ago, due to fluctuations in plant loadings and difficulties in securing adequate technical control.

One of the most striking statements by Mr. Donaldson was as follows: "The drying of filter cake to make a fertilizer is not now a commercial success, and for several important projects attention is being given to incineration of the filter cake."

In discussion, Mr. Pearse not only corroborated the statement just quoted but said that it is no secret that at Milwaukee T. C. Hatton (who designed and built the activated-sludge plant and has recently returned as consulting engineer) is considering incineration of the excess sludge. Studies to the same general end have been made by the Chicago Sanitary District, Mr. Pearse said, and a 20-ton drying and incineration plant is to be built and run for test purposes.

Refuse Incinerators—In the report on sanitary progress, commenting on the recent re-taking of bids for two incinerators at Washington, D. C., and on one detailed set of plans and specifications drawn by consulting engineers instead of on bidder's designs, the committee said:

> Thus all bids received were on a directly comparable basis. Such a development is encouraging, as the value of the engineer in the field of garbage and refuse disposal has been greatly hampered by the all-too-prevalent method of calling in an engineer to try and determine what to accept, after bids have been taken from a number of manufacturers, with resultant confusion through the lack of uniformity in the character of the work offered.

In discussing the report, H. P. Eddy, of Metcalf & Eddy, Boston, designers of the Washington incinerators, said that the legal ruling at Washington on the bids under incinerator builders' designs raises a question of general application to the legality of any bids based on bidders' guarantees; obviously, he added, in the second biddings at Washington there were no guarantees on materials and workmanship. H. Burdett Cleveland, New York, said that the recent Washington letting is a new step in incinerator purchasing; it reduces all bids to a common denominator and removes camouflage as to the merits of one manufacturer's type over another.

Executive Committee—The executive committee reported the creation of a joint committee of salvage of sewage, from the irrigation and sanitary divisions, with Richard R. Lyman, Salt Lake City, chairman.

Wind-design report

The first half of the joint meeting of the construction and structural divisions was devoted to the report of the committee on windbracing of steel buildings. Briefly, the committee made no change in the wind force prescribed in its first progress report (*ENR*, Jan. 26, 1931, p. 198), but explained more clearly its previous stipulations regarding stability and limiting stress in members carrying wind loads, recommended the Hardy Cross method of distributing fixed-end moments as an accurate and labor-saving method for analyzing wind bents of moderate height, illustrated effective and economical types of bracing, approved the use of rivets in tension and gave some attention to proper wind-connection detailing.

The committee's recommendation of a wind force of 20 lb. per sq.ft. for the first 500 ft. of height, increasing in increments of 2 lb. per sq.ft. for each additional 100 ft. of height, was left unchanged, no discussion received being considered important enough to warrant any revision. The committee concludes that its wind force prescription "should be adequate for any part of the United States or Canada."

Two new recommendations were made. A new stability provision is that the axial wind tension in any column be not more than two-thirds of the dead-load compression, unless the column is securely anchored to the foundation. The committee amplified its previous statement on permissible stresses, recommending that members or details subjected to wind only, except rivets and bolts, be designed with the same stress permitted for vertical loads, and that members subjected to combined wind and other loads be designed with a stress 33 1-3 per cent in excess of that allowed for vertical loads.

Two sections of the report were devoted to windbracing arrangement and connection details. Recognizing the value and often the necessity of using split beam or "knuckle" connections, the committee nevertheless points out the desirability of utilizing diagonal bracing of some kind in high narrow frames. Rigidity is the principal requirement in windbracing connections, and can be secured by keeping rivets near the root of the connection angle.

The most active discussion of the session centered on wind-tunnel model studies and was occasioned by a description by H. L. Dryden, chief, aerodynamical physics section, U. S. Bureau of

Standards, of recent tests on a 1:250-scale model of the Empire State Building made in the wind tunnel at the Bureau of Standards. Mr. Dryden prefaced his remarks by citing the success that has attended the use of model experiments in aircraft design practice. The Empire State experiments were made to determine wind-pressure distribution on the building, to secure more data on the relation of wind speed to load, and in general to assemble model-behavior information that may be compared with results to be obtained on the actual building. Pressure-recording instruments were installed at three elevations in the model, which was set up at various angles to the wind stream in the tunnel. Scale effect was found to be negligible, amounting to not more than 5 per cent for square-corner models. In the pressure studies, a considerable negative pressure was recorded on both sides and the back of the model, varying with the position of the model relative to the windstream. Positive pressure on the windward side was about equal to the indicated windstream pressure, while the negative pressure on the back of the model was about one-half this value, making the effective pressure on the model 1½ times the windstream pressure.

The overturning moment of the model checked the pressure measurements fairly well. Speeds 20 per cent higher than the wind speed approaching the model were recorded a short distance above it.

Dean Milo S. Ketchum, University of Illinois, stated a belief that wind tunnels cannot provide a measure of severe wind effects such as those caused by tornadoes, especially because of gust violence. Referring to the Southern Illinois tornado of several years ago, he remarked that well-designed buildings were not destroyed, self-supporting chimneys stood up well, elevated tanks proved vulnerable. A. J. Hammond concurred in Dean Ketchum's doubt concerning the usefulness of model studies to determine tornado effects, citing his experience in witnessing the pulsations and turbulent nature of the wind in the Havana hurricane. Prof. Clyde T. Morris, Ohio State University, thought model studies were useful in reproducing Gulf Coast hurricane effects but doubted their usefulness for tornadoes.

Foundations

The remainder of the session was devoted to foundations. While the papers varied considerably in scope, each was planned to sketch the present status and future possibilities of the art and to describe good practice.

Building Foundations—In introducing his paper on building foundations, Carlton S. Proctor, consulting engineer, New York, characterized foundation work as a "branch of engineering continually leading to new methods and new solutions and requiring constant investigation and research." Too many foundation designs are replicas of successful designs used elsewhere, in the opinion of Mr. Proctor. In speaking of soil conditions as they affect design, he referred to the Albany Telephone Building (*ENR*, Nov. 27, 1930, p. 836) founded on supersaturated clay, where stability could be assured only by equating the cellar excavation to the weight of the building. Here the substructure was designed as a series of two-story Vierendeel trusses to give uniform bearing on the soil. As to construction methods, he outlined the successful development of open-pier methods in soft New York foundation soil (*ENR*, March 26, 1931, p. 515). At the present time in Pittsburgh an open cofferdam is being carried down to rock 80 ft. below the street and 40 ft. below groundwater level for the new federal building and postoffice.

Thomas Crimmins, New York contractor, in discussion, also stressed the importance of complete foundation design, because the contractor, under modern conditions, is pushed too hard for time to study out and revise incomplete plans. He thought that, regardless of the development of successful open methods, a contractor should have an air plant for emergencies. Theodore L. Condron, consulting engineer, New York, presented a paper describing the boring and test-pile investigation that preceded the pile-foundation design for the new Point Breeze plant of the Western Electric Co., at Baltimore, Md.

Subway Foundations—Lazarus White, New York, based his paper on subway foundations on a consideration of two principal factors—effect of groundwater and non-uniformity of pressure upon the bottom of the subway box. He reviewed the changes in waterproofing practice from the encircling membrane in the early subways to the virtual omission of it in many sections of the New York subways today. Waterproofing is still used universally for the roof. In Philadelphia an elaborate drainage system has been installed so that the subway does not have to be designed to resist groundwater pressures. The use of a drainage system saves the cost of waterproofing, lightens the structure, and by lowering groundwater decreases the cost of neighboring excavations. On the other hand, pumps are expensive in first cost, maintenance and operation, and neighboring wood-pile foundations may be damaged by lowering the groundwater.

Regarding distribution of pressure on the subgrade, Mr. White believes the uniformity assumption erroneous and expensive to follow and showed slides of a test set-up that revealed concentrations or "bulbs of pressure" under the walls. The most economical subway foundation, he holds, is one with a heavy bottom section under the wall and light floors over the balance of the bottom.

In discussion, Charles H. Steven, chief engineer, board of city transit, Philadelphia, told of his city's practice of using drainage instead of waterproofing except in special locations. In the Philadelphia subways the walls are reinforced near the bottom and tied to the invert so as to assist in carrying part of the vertical load. The drainage consists of tile drains on the center line, supplemented by sump pumps.

C. M. Hale, Marcus Contracting Co., New York, minimized the importance of groundwater, since much of it is known to flow back into adjacent soil after a subway cut is made. While permanent pump systems may often be economical, they are questionable where material is of a nature that will clog the drains, he said. Waterproofing often leaks, so that care should be exercised to secure as dense a concrete as possible. Subway design should be planned for easy construction instead of for least volume of materials. The bulb-of-pressure theory, concluded Mr. Hale, is more applicable to narrow subways where vertical loads are closely grouped than to wide sections.

J. R. Slattery, deputy chief engineer, board of transportation, New York, pointed out that subway design must necessarily be planned for mass production. The usual practice of New York is to design for uniform pressure but to use footings under the columns connected by a 12- to 16-in. slab that carries the track load and acts as a strut between footings to transmit lateral thrusts.

Bridge Foundations—In his paper on bridge foundations Joseph J. Yates, bridge engineer of the Central Railroad of New Jersey, stressed the necessity for careful investigation of soil conditions so as to remedy the over-foundationing that has occurred on many bridge structures in the past.

Mr. Yates concluded his paper by describing a wood-bottom caisson job (Flushing Creek bridge on Long Island, *ENR*, July 14, 1927, p. 48) and a concrete-bottom caisson job (Newark Bay bridge of the Central Railroad of New Jersey, *ENR*, Feb. 4, 1926, p. 184).

Surveying and mapping

Geodetic control for highway location will be possible in North Carolina in about two years, according to George F. Syme, senior highway engineer of the highway commission, who outlined the advantages of this forward step. By means of a contract between the highway commission and the U. S. Coast and Geodetic Survey (the legislature having refused to appropriate necessary funds) the state is being cut into areas by first-order triangulation at intervals of about 100 miles, and these will be cut by second-order arcs so that no

point in the state will be more than 25 miles from a triangulation station. The highway commission will then build up a supplemental system of monumentation of an accuracy at least 1 in 5,000, which will be available for all engineering work.

Power division

To insure ample time for discussion, the power division gave over its entire meeting to consideration of the work of the Federal Power Commission. George Otis Smith, chairman of the commission, spoke, taking for his subject, not the details of the commission's work, but what, from his point of view as an outsider, should be the engineer's attitude to power matters. Engineers, he said, should help to fill in the gaps that now exist in statistics of the power industry and then should help in educating the public as to how these statistics should be interpreted to give a true picture of the industry. Much of the present opposition to the power companies, he said, is due to the lack of a correct analysis of all the facts bearing on the power issues, especially the spread of cost between production and ultimate consumer.

J. P. Hogan, New York, in discussion, stated that the St. Lawrence marketing board, of which he was a member, had endeavored to determine for the St. Lawrence commission the spread of cost between the cost of production and the cost to the ultimate consumer. No such figures are available to the public, he said, although the power companies have made studies of their own for rate determinations. Assigning the spread definitely to different classes of service was found to be difficult because of many indeterminate factors involved. However, Colonel Hogan stated, the power companies should make their figures, incomplete though they be, available to the public if they ever hope to correct the impression that most of the spread between production and consumer is profit to the company.

Plans of the newly organized water-power policy committee of American Engineering Council also were outlined by Colonel Hogan, a committee upon which he represents the Am. Soc. C. E. The committee would welcome suggestions as to the scope of its work.

The need for adequate funds for the Federal Power Commission for the collection and analysis of power statistics was emphasized by Edwin F. Wendt. He cited the case of the commerce commission as an example of how much time and money was required to be spent before the commission had all the facts required to prove that the railroads of the country were not overcapitalized. A further comparison with I.C.C. fact finding was made by F. W. Doolittle, New York. He pointed out that the commission's classification of property was not developed in the most useful form for a determination of rates. It does not lend itself to proper segregation.

Committee Reports—L. F. Harza, chairman of the committee on the safety of dams, reported that the draft of a model law for the supervision of dams is in the hands of a subcommittee and may be available before the next annual meeting. The chairman of the division, L. S. Bevan, reported that J. C. Stevens was preparing a report on silting for the committee on that subject. He is working on this in conjunction with the society's committee on irrigation hydraulics. Chairman Bevan also drew attention of the division to the outline of future work published in the July issue of *Civil Engineering*. So far few members have indicated their preference as to subjects.

City planning division

Broad considerations of city planning and regional development gave way very completely to discussion of detail operations of city management in the program of the city planning division. A paper on location of underground utilities, by A. W. Consoer, consulting engineer, Chicago, described various local activities toward standardization, and particularly those of the Chicago Regional Planning Association. A particularly desirable thing, Mr. Consoer thought, was long-period planning by utility companies in building their underground facilities. They should build for perhaps fifteen years ahead of the requirements at the time of construction. In discussion, Bancroft Gerhardi, American Telegraph & Telephone Co., spoke favorably of some further action to formulate general principles but thought some reservations were warrented in urging detailed codes and long-period planning. W. W. Horner, chief engineer, streets and paving, St. Louis, Mo., called attention to the fact that while it was the natural inclination of the paving engineer to cherish the integrity of his pavement as of first importance, the facts were that in modern city streets the underground structures represented a larger investment and had perhaps as great potentialities of public service as did the pavements. Maurice Serating, mechanical designer, board of transportation, New York City, while agreeing that some action toward arriving at some statement of general principles would perhaps be helpful, opposed the idea that any precise codification or long-period planning was possible. He believed that every problem as it came up must always be solved by itself.

The second paper of the session, though carrying the rather vague title of "Street Names and Numbers," proved to be an unusually clear presentation of principles for naming streets and numbering houses in cities. It was read by J. P. Schwada, city engineer of Milwaukee, Wis. The various practices in naming and numbering in current use were described, and the recent plan of systematic naming and numbering in Milwaukee was described in detail. The general principle laid down as a basis for the new system was that primarily it should be one that best served emergency needs of quick and precise location such as confronted police, fire and hospital service; secondarily, the transportation agencies, such as taxicabs; and finally, the convenience of the individual citizen and occasional visitor.

Engineering education

Prof. J. K. Finch, Columbia University, in a paper on the place of surveying in engineering education, emphasized the importance of the summer camp as a place where classroom and campus practice knowledge may be utilized in producing finished results under conditions pertaining in actual engineering practice. More knowledge of geodetic surveying methods should be required and less of complicated astronomical facts. Aerial surveying is important but will for many years be the work of specialists and not of civil engineers, in the opinion of Professor Finch.

Some of the broader phases of engineering education were considered in a report by Prof. Theodore L. Crane, of Yale University, chairman of a construction division committee on the subject. Briefly, the report urged greater cooperation on the part of the construction industry in placing graduates, in providing summer work, and in having well-known construction engineers give lectures to students. Professor Crane remarked upon the backwardness of the construction industry in this regard as compared with other industries, notably the electrical.

Board of direction acts on economic matters

Action on matters of engineering economics by the board of direction of the American Society of Civil Engineers stands out as of major importance among the many subjects considered at its two long meetings held in conjunction with the society's annual meeting. The board voted to join the Construction League of the United States as a charter member, and it approved the principal of the proposal of the American Water Works Association calling for immediate planning of waterworks betterment as a means of unemployment relief. This proposal was outlined in these pages two weeks ago. The board also appointed a committee to consider and report upon the proposed stabilization plan of Frederick H. McDonald, secretary of the society's division of engineering economics, entitled the compulsory stabilization reserve fund as business insurance.

In professional matters the board approved the proposal made by the joint committee on state engineering councils and endorsed by American Engi-

neering Council for setting up state councils of professional engineers. These councils would be made up of representatives of engineering societies and would act as a clearing-house for all matters of interest to engineers in the state and as their spokesman in legislative and other matters where action by engineers is desirable.

Six professional conduct cases were acted upon by the board.

The setting up of local sections at Chattanooga, Tenn., and at Ithaca, N. Y., was authorized, also student chapters at the University of Delaware and at North Dakota Agricultural College. Plans for student chapter activities, as reported by the committee on student chapters, were considered in detail.

The board decided to hold a fall meeting at Atlantic City. The summer meeting will be held at Yellowstone Park, probably in late June or early July. There will be no spring meeting, the board having decided to eliminate it at the time of the meeting in St. Paul.

Twenty-three of the 26 members of the board were present at the meeting. An unusual amount of time was devoted to budget matters, due to the prospective decline in income of the society for the year 1932.

Contractors Discuss Legislation and Business

Thirteenth annual meeting of A.G.C. at Milwaukee devoted to plans of industrial revival through construction—Starrett and Kaiser to head organization

Engineering News-Record Staff Report

THE thirteenth annual convention of the Associated General Contractors of America, held in Milwaukee from Jan. 18 to 22, was devoted to a serious consideration of ways and means to end the present business depression through a sound construction program, and to a study of the mass of proposed legislation affecting the construction industry directly or indirectly. About 400 were in attendance, with the Milwaukee chapter of the A.G.C. acting as hosts to the meeting. W. A. Starrett, of Starrett Bros. & Eken, New York, was elected president for the coming year but was unable to attend the meetings because of illness. Henry Kaiser, of the Kaiser Paving Co., Oakland, was elected vice-president-at-large and took charge upon the retirement of A. P. Greensfelder, past president.

The sense of the four-day meeting was summed up in a resolution urging the continuance of construction on a sound basis for the relief of unemployment, with due consideration for taxpayers. This resolution further urged the support of only those relief measures that have been carefully considered and found to be of real public worth.

Legislation considered

It was reported that there are now before Congress some 245 bills affecting construction. A few of these were discussed in full, and definite recommendations were made by the convention concerning them. The proposed amendments to the Bacon-Davis prevailing-wage act were approved by the legislation committee and the executive board. These amendments would specify the predetermination of wages and their stipulation within the contract, the adjustment of contract prices corresponding to wage changes ordered by the government, the extension of the act to all public works, and the provision of a suitable penalty for infraction without loss of contract. Before this could be put to the convention for final consideration, notice was received of President Hoover's executive order demanding that the act be enforced and providing for abrogation of the contract in case of infraction. The convention immediately protested the President's action, stating that the order would tend to increase the confusion already existing under the indefinite Bacon-Davis act, which might be declared constitutional. Suspension of the order was requested until the A.G.C. might have an opportunity to present the employers' viewpoint.

The Bingham-Goss bill, calling for the contractor to submit with the bid a list of subcontractors and material dealers with whom he intends to do business, was vigorously opposed by the convention. It was declared to be vague, indefinite, difficult to enforce and lacking all protection to the contractor against the failure of the subcontractor to go to work or against raise in prices, once the sub-bidders' names were declared.

The Cochran bill for the establishment of a department of public works was endorsed by the convention, as was also the uniform contract bill, which would replace the 800 laws now governing governmental contracts. The association went on record as opposing all legislation, local or national, that restricts contracts to local contractors' labor or materials, but it urged that local labor be used wherever possible to relieve local unemployment. It was also agreed to cooperate with other interests of construction in backing up one or two of the relief programs now before Congress and to oppose the rest, inasmuch as united efforts will be needed to get any of them passed in the face of organized opposition from taxpayers' leagues.

Construction a way out

Pointing to construction activities as a means of business revival, Willard T. Chevalier, publishing director, *Engineering News-Record*, told the convention that:

> Search for a business activity to lead the nation out of the depression has logically turned to the construction industry, administered through the federal government and local communities to the extent that construction in 1931 compared favorably with that of 1929. Continuance of the construction program depends upon the willingness of the taxpayers to finance, and the investors to buy, bonds of private enterprise. Both will be affected by restoration of confidence through enactment of the relief program before Congress.
>
> Now with construction costs lower than in decades, with ample basis for credits, with deferred buying, the stage is set for a large construction program if the element of confidence can be introduced. It is toward this end that all government effort is being directed.
>
> In mapping a program of public-works construction to relieve unemployment it is important that relief funds be not squandered in unnecessary projects or by wasteful methods. Funds for relief can come only from surplus earnings of those already employed, either in taxes or donations.

Col. Chevalier deplored the short-sighted policy of some communities in the replacement of normal construction operations by hand labor. He advocated the use of hand labor only on additional work beyond normal activities, and if possible concentrated upon classes of work that must necessarily be done by hand.

Adjust building wages

A resolution was passed by the convention asking for an adjustment of wages of construction labor to stimulate construction and employment without putting such labor on a distressed basis. This stand was reiterated by Frederick L. Cranford, of Brooklyn, who stated:

> Fear is what is tying up the whole industrial activity today, with the bankers being the most scared. It is up to American business men to take the lead and tell the country to get to work. Bankers, lawyers and politicians are unable to lead the way. A readjustment of building trades wages is sorely needed at this time to encourage the start of several billion dollars worth of construction. . . . Construction finance is also way out of line, home-building labor is too high, secondary finance is too high. Home building is now subject to discouraging financial juggling.

Mr. Cranford urged the supervision of the electrical industry and other public utilities by public service commissions to prevent their charging excessive construction and engineering

costs into capital expenditures upon which rates are to be based.

A cure for a sick industry

"Who's who in the construction industry is answered best by those following the A.G.C. motto of skill, integrity and responsibility," said S. M. Williams, president of the bureau of contract information. "The construction industry is a sick industry because of lack of consideration of others in the industry, because interest in construction stops usually with the activities of one's own firm, and because the other fellow is ignored," declared Mr. Williams. "In 1928 a campaign for sane credits was launched, yet those who yelled the loudest for it were the first to demand loose credits for themselves." He emphasized the need of cooperation with those interests that are standing behind good construction practices. He also urged recognition and support of those who are helping the industry; otherwise, he declared, the industry will remain a sick one.

A proposal was made to establish a secretariat and publicity committee for the handling of the International Federation of Building and Public Works meeting to be held in Washington, D.C. It is proposed to ask 400 manufacturers to donate a total of $100,000 to finance the meeting.

Membership report

During the year, 369 new members were secured and 456 dropped out, leaving a net loss of 87, bringing the total membership down to 1,777. There are 95 chapters in the association, three new ones being formed the past year. Three student chapters now exist, at North Carolina State College, Massachusetts Institute of Technology and Virginia Polytechnic Institute.

Henry Kaiser, of Six Companies, builders of Hoover Dam, and Geo. Walbridge, chairman of a special investigating committee on working conditions at the dam, presented talks and moving pictures depicting the magnitude and speed of construction of the project. In driving the 41×56-ft. enlarged headings, from 240 to 260 ft. per day is being maintained in eight headings.

Construction credits

Ward Christie, of Ulen & Co., spoke on the need of better contacts between bankers and the construction industry. He pointed out how the tendency of more surety bonding and new lien laws are providing instruments of automatic credit, enabling those without credit to operate and thus placing the legitimate contractor under a handicap. He urged unqualified support of the bureau of contract information, which is in a position to offer indirect evidence of responsibility, highly important to the welfare of contracting, and he deplored the patronage of irresponsible surety companies by responsible contractors.

Both Geo. B. Walbridge and B. L. Knowles warned the convention that if prequalification is to reach the desired wide acceptance, contractors must not use prequalification for selfish purposes. Four states adopted prequalification during the past year.

The convention endorsed the action of the executive board in joining the Construction League of the United States, and authorized the payment of dues. The league meets in St. Louis on March 20.

Col. E. M. Markham, U. S. Engineers, outlined the proposed work on the Great Lakes and the St. Lawrence waterway. He predicted a ten- or twelve-year program of $163,000,000 for the Great Lakes and $250,000,000 for the St. Lawrence.

No action on licensing

No stand was taken by the convention as a whole on licensing contractors or on estimating fees. It was decided to leave both of these controversial questions to the individual chapters to work out. The national association has prepared a model licensing law for use of chapters if desired.

Prof. Walter C. Voss, of M.I.T., urged that some plan be worked out for taking care of graduates of A.G.C. student chapters and asked for more student chapters. He suggested a construction-engineering section for taking care of these graduates. M.I.T. now has a construction scholarship that provides for four years of study and three years of guaranteed employment. If the A.G.C. slogan of skill, integrity and responsibility is to be taken seriously, the association must have foresight to train into the men who are stepping into construction work the character and integrity that the A.G.C. demands.

Highway financing

E. W. James, of the U. S. Bureau of Public Roads, advocated a new method of distributing highway funds according to traffic count in various communities. Traffic originating within that community would have to be taken care of by local funds, but foreign traffic would be taken care of by funds from a pool, the distribution from and contributions to the pool depending upon the proportion of foreign and local traffic within a community.

Resolutions

Besides the resolutions already referred to, several others were approved. Thanks were extended to President Hoover and Secretary Lamont for their good wishes. The adoption of a cooperative construction credit system was urged. Prequalification for all governmental bodies was called for by another resolution. A bill for the establishment of a home-loan discount bank was suggested. The establishment of a construction bureau based on certified appraisals was urged. Sorrow was expressed over the death of James Cashman, Philip Koehring and others who died during the past year. Further federal aid on highway work, similar to that of 1931, was urged. Convict labor competition was condemned.

Why Detroit Has Curtailed Its Public Works

To balance its budget after a decade of extensive construction the city has discontinued improvements and discharged hundreds of engineers

By Harrington Place

Engineer, Bureau of Governmental Research, Detroit, Mich.

WITHIN the past three weeks Detroit has stopped all construction of public works. A city which in 1929 gave evidence of activity on every hand, in every line of construction, it is now continuing only routine operations, and this with greatly reduced forces. Tax-collection deficits are a prime reason.

Detroit's first great growth occurred between 1910 and 1920, but when the war intervened public works were stopped. The influx of population in these years was greater than could be comfortably housed. A building boom followed, and the demand for pavements, sewers, water and other public utilities could not be denied. So, during the lean years of 1920-21 Detroit was practically the only large city that prosecuted a considerable program of public work.

After 1920 the population growth continued undiminished, the city's area increased disproportionately, and its debt outstripped both. Table I gives the figures.

A decade of construction

In 1920 a $25,000,000 sewer program was begun, to care for the outermost

parts of the city. At the same time an extensive program of paving was begun, starting in 1920 with 550,000 sq.yd., at a cost of 3½ millions. A decade of intensive construction began.

In the middle of this period, in 1925 and 1926, the foundations of the present troubles were laid by the annexation of about 40 square miles of territory, mainly on the north and west sides of the city. It created the necessity for additional sewerage, water, pavements, schools, police and fire protection. The paving program increased until 1927, when a total of nearly 3½ million yards of pavement was laid at a cost of nearly $12,000,000, largely in the newly acquired territory. In 1928 another bond issue of $30,000,000 for sewers was voted, and many miles of water main were laid.

Budget problems

As long ago as 1925 the mayor appointed a citizen's finance committee, which outlined a long-term construction program; but that program was never followed very closely. Late in 1929 Ralph Stone, chairman of the board of the Detroit Trust Co., addressing the Detroit Real Estate Board, outlined the procedure that he would follow were he in a position to correct the financial status of the city. Soon afterward, at the request of the city council, he formed a committee to cooperate with the city in preparing the annual budgets and balancing them.

Yet, in spite of the care given to budget preparation under the influence of this committee, budgets have been exceeded and deficits have resulted. Thus, the 1931-32 budget contemplated these expenditures:

Fixed charges (interest, debt retirement, and police, fire and general pensions)	$29,057,195
Deficits in operation of previous years	6,681,856
Street-railway operation and capital outlay (debt service under fixed charges above)	25,075,785
Water-board operation and capital outlay (exclusive of debt service)	3,771,509
Board of education	31,064,274
City departments (including library), operation and improvements	57,018,064
Total	$152,668,683

These expenditures were to be financed as follows:

Taxes	$76,029,513
Bond sales	23,201,000
Street-car fares	23,187,725
Water rates	8,073,704
Primary-school fund, tuition and other board of education revenues	10,058,250
Departmental revenues other than above	12,118,491
Total	$152,668,683

Balancing the budget

When closing the books on June 30, 1931, however, it was found that the tax collections were short $11,500,000—an unforeseen contingency. The year's budget had made no provision for such shortage. Moreover, $13,000,000 had been expended for welfare relief in 1930-31, but no provision for this item was made in the 1931-32 budget. Evidently the budget was not balanced.

TABLE I—DETROIT'S GROWTH AND FINANCES

(From "The Growth of a City Government," L. D. Upson, Detroit Bureau of Governmental Research, 1931)

Date July 1	Population	Area, Sq.Mi.	Assessed Value in $1,000	Tax Budget in $1,000	Per Capita Tax	Net Debt in $1,000	Per Capita Net Debt
1824	1,550	1.36					
1860	45,619	12.75	$54,046	$205	$4.50	$954	$20.92
1900	285,704	28.35	237,799	3,662	12.82	4,427	15.50
1910	465,766	40.79	372,070	6,837	14.68	7,242	15.55
1915	673,498	41.76	554,382	13,106	19.46	15,864	23.55
1920	993,687	79.62	1,698,006	35,086	35.31	26,682	26.85
1921	1,045,624	79.92	1,853,196*	40,164	38.41	67,888	64.93
1922	1,030,420	82.32	1,954,184	43,098	41.83	108,089	104.90
1923	1,096,947	84.65	2,109,989	47,409	43.22	131,419	119.81
1924	1,158,985	92.66	2,455,327	51,476	44.42	145,769	125.77
1925	1,246,044	119.13	2,757,664	56,209	45.11	161,631	129.72
1926	1,368,220	139.02	3,160,412	71,318	52.12	193,752	141.61
1927	1,383,000	139.02	3,394,333	76,030	54.98	201,384	145.61
1928	1,410,000	139.02	3,562,213	76,571	54.31	227,930	161.65
1929	1,423,000	139.02	3,681,781	76,045	53.44	238,598	167.67
1930	1,568,662	139.02	3,774,861	76,071	48.33	275,911	175.29
1931	1,570,000	139.02	3,358,431	76,029	48.85	306,329	194.62

On July 14, 1931, the council adopted a policy that the city should live within its cash income; deficits were declared taboo. A quarterly check on expenditures and revenues was prescribed, to see that expenditures were kept within such limits and a balance guaranteed.

Some necessary budget revisions affected the situation. Estimates of tax collections were reduced from $76,029,513 to $63,000,000. Departmental credits were reduced to $2,758,749. Appropriations totaling $7,000,000 were approved for general welfare relief, financed from a bond sale last August instead of accruing as a deficit. Financing of $6,679,882 deficits in the 1931-32 budget was postponed. Meanwhile the assessed valuation shrank from $3,774,861,100 in 1930 to $3,358,431,390 in 1931. And on Dec. 31, 1931, the collection of taxes showed a further drop of six millions. These changes demanded strong action.

The debt situation also was a factor. The voters or the council have authorized bonds in excess of $38,000,000 for public improvements, nearly $14,000,000 beyond the limit established by charter. The total margin of bonds for the several municipal purposes on June 30, 1930, (Table II) is ample, but the market for bonds has been and still is so poor that even in the face of the shortage in tax collections the city has been getting along on short-term notes.

This fact finally precipitated action, for even after drastic retrenchments in operating departments the city at the beginning of 1932 was not balancing the budget. Therefore the bankers who had furnished the short-term loans by implication issued the ultimatum, "Balance the budget or no money!"

Curtailment of work begins

Pursuant to action by the city government last fall, all new construction has been stopped. *No public improvements will be undertaken during the next five years*, so far as practicable. After the retrenchments already carried out, the final thing to do was to cut salaries and skeletonize. This was done the first of the year.

TABLE II—DETROIT'S BOND MARGINS

General public improvement bonds (limit 4 per cent of assessed value, $3,774,861,000)	$150,994,444.00
Net outstanding bonds	126,821,300.77
Margin for future issues	$24,173,143.23
Water bonds, (2 per cent limit)	$75,497,222.00
Net outstanding bonds	44,421,633.12
Margin	$31,075,588.88
Public lighting bonds, (1 per cent limit)	$37,748,611.00
Net outstanding bonds	18,814,984.62
Margin	$18,933,626.38
Street railway bonds, (2 per cent limit)	$75,497,222.00
Net outstanding bonds	22,790,209.47
Margin	$52,707,012.53
Library bonds, (¼ per cent limit)	$9,437,152.75
Net outstanding bonds	2,936,666.54
Margin	$6,500,486.21
School bonds (no limit)	.....
Net outstanding bonds	$60,127,048.77

Subway bonds:

There is a permissive bond limit, if any bond issue is approved by the voters, of 2 per cent of assessed value, which is $75,497,222. No bonds have been authorized or issued.

All salaries up to $4,000 were cut 10 per cent, others an additional 10 per cent on the amount in excess of $4,000. Other changes are as follows: in the water department 52 engineers have been dismissed since Dec. 30. (The large tunnels had been completed, and engineers engaged in those activities have been dismissed during the past several months. The Springwells station is about 95 per cent complete, and the men employed there might have expected layoff by next August at the latest.) In the department of public works 127 men are out, leaving 111 in service. In the city planning commission ten out of thirteen have been released. The rapid-transit commission has released one, and the department of building and safety engineering its entire smoke-inspection division of 59 men.

It may be timely to add that in the summer of 1930 the water supply was taxed to its limit, but during the last year part of the new supply has become available, and consumption has fallen off about 15 per cent, so that danger of water shortage is remote. Further, the new plant is so near completion that comparatively little harm will be done by a cessation of activities now.

Letters to the Editor

Cantilever Concrete Bridge Cost

Sir—I cannot allow to pass unchallenged the claim of economy made by the designer for the freak cantilever bridge of concrete recently built at Montrose, Scotland. (*ENR*, Aug. 20, 1931, p. 300; discussion by H. G. Perring, Oct. 1, p. 540; reply by Sir E. William Owens, designer of the bridge, Nov. 12, p. 784. See also description in *Engineering and Contracting*, Sept. 1931, p. 229.) The suggestion that a concrete bridge of such type and span length could be more economical than a corresponding steel bridge can hardly be taken seriously.

The published accounts indicate that the bridge is 432 ft. long (216-ft. cantilever span and two 108-ft. anchor arms) and 36 ft. wide (20-ft. roadway and two 8-ft. sidewalks) and is designed for a live load of 200 lb. per sq.ft. on the roadway and 100 lb. per sq.ft. on the sidewalks. Of the total cost of $435,000 the designer allocates only $250,000 to the bridge proper ($150,000 for the substructure, excluding abutments, and $100,000 for the superstructure). According to these figures, the cost of the bridge proper (at 1930 prices) was $16 per square foot. A steel bridge of the same type, dimensions and loading, for the same foundation conditions, can easily be designed to cost not more than $11 per square foot.

According to the published description, the curved top chords of the cantilevers are each subjected to tensile forces of 1,000 tons and are reinforced with 76 1½-in. steel bars (or 134 sq.in. of reinforcement). In a corresponding steel bridge design, with the reduced dead load, the chord stress would be less than 600 tons, requiring a cross-section of only 80 sq.in., or 40 per cent less than the reinforcement alone in the concrete design. The use of reinforced concrete for tension members is illogical and obviously wasteful. The use of reinforced concrete for a truss design cannot be economical where steel is available at ordinary prices. The dead load alone is nearly trebled.

If the superstructure of the concrete cantilever bridge cost $100,000, a corresponding design in steel, with the reduced dead load and the greater efficiency of steel, would not cost more than $70,000, at comparable unit prices. With the very considerable reduction in the dead-load reactions, there would also be a saving in the substructure of at least 30 per cent, or $45,000. The cost of the bridge proper would thus be reduced from $250,000 to $175,000 or less, if designed in steel.

If the designer of the concrete cantilever bridge will accept the challenge and submit stress sheets, quantities, and unit costs, American bridge engineers are prepared to disprove his claim that concrete can be an economical material for a bridge of such design.

It is regrettable that a freak structure of inappropriate material should have been allowed to succeed the previous 100-year-old suspension bridge. Sentiment, tradition and esthetic considerations would have indicated a suspension design as the ideal successor of the famous old bridge. When the century-old suspension bridge at Newburyport, Mass., was replaced in 1909, special effort was made to perpetuate both type and form of the historic bridge in the new structure. It is disappointing to see the Old World adopting the bizarre merely because it is novel, and yielding leadership to the New World in respect to fitness and tradition.

New York City, Dec. 15, 1931. D. B. Steinman.

French Suspension Bridges

Sir—Of considerable engineering interest to a traveler in France are the numerous wire-cable suspension bridges along the River Loire. Some of these have two or more spans, and nearly all of them are of great age, as evidenced by their primitive construction and timber trusses. The particular feature that attracts attention, however, is the general use of tie cables of considerable size between the towers.

These bridges, after many years of service, have about reached the limit of their usefulness. One of these, at Montjean, near Angers, built in 1840 (as noted by E. F. Keuster in your issue of Jan. 15, 1931) was rebuilt in 1927. It was there stated that American engineers had attempted to patent tie cables for suspension bridges, only to find that they had been patented in France in 1835.

Judging from the numerous examples of tie-cable suspension bridges of early construction now to be found along the Loire, many were constructed not long after the above date, and they evidently became the popular type for spanning this river. Among these numerous tie-cable suspension bridges are two crossing the Loire at Tours, which may be described. The Pont Suspendu de St. Symphorien, built in 1847, has cast-iron tower columns on each side of the bridge, hinged at the floor level. Each of these columns supports two wire cables, which in the main span are alternately connected by hangers to wood floor beams. These cables, as well as those on other bridges, are looped around pins at top of the tower columns. The cast-iron tower columns are limited in longitudinal movement at the top by tie cables of considerable size, practically in a straight line between towers, and also between towers and abutments. Teams are not now allowed to go over the bridge. A similar bridge a short distance below is illustrated herewith. It, however, has masonry towers, on which the saddles supporting the cables are limited in their movement by the tie cables.

There is considerable variety in the design of the several bridges. While most of them have wire cables, a few use bar-iron chains and hangers. On one bridge four small cables in a horizontal plane on each side between towers are turned into a vertical plane between towers and abutments. The village blacksmith apparently had fashioned the details in many instances.

It is said that the first suspension bridge in these parts was erected in 1826. Since that time these bridges have very economically served to bridge this wide river subject to heavy floods where long spans and unobstructed waterways were required. They should have an important place in the history of suspension bridges.

George W. Tuttle.

New York City, Dec. 12, 1931.

Two-span suspension bridge (Le Pont Bonaparte) with horizontal tie cables over Loire River at Tours, France.

NEWS OF THE WEEK

Prevailing Wage Written in Contracts by Executive Order

WHATEVER necessity Congress may attach to the need of strengthening the provisions of the prevailing wage law as applied to public building contracts has been lessened appreciably by an executive order issued by the President, the effect of which is to give government contracting officials greater authority in enforcing the Bacon-Davis act.

Under the terms of the order, the stipulations set forth will be made a part of all future contracts involving public building construction. The contractor must agree that he will pay his employees at least once a week without deductions or rebates; that his payrolls and those of his subcontractors will be open to inspection by government officials; that a statement of the rates payable will be posted so as to be accessible to all workers; and that refusal to pay the prevailing wage will result in the abrogation of the contract by the government. In the event the government takes over the work, the contractor and his sureties are made liable for any extra cost occasioned.

Meanwhile the House labor committee has been conducting hearings on bills designed to widen the scope of the act. Many cases have been reported that do not come under the present law. Representative Beedy, of Maine, for instance, complained that the law does not apply to demolition work. Chairman Connery, of the committee, has introduced a bill which would impose a penalty of $5 a day on each violation. This bill would apply to all public contracts involving the employment of laborers and mechanics, regardless of the amount of the contract or the kind of work. The present law applies only to public building contracts involving $5,000 or more.

Reduction in Salary Asked by Village Engineer

A voluntary request for salary reduction has been made by Victor E. Hammerlein, village engineer, of East Aurora, N. Y. He gave as his reason the reduction in living costs and economy measures of all communities. He receives $4,000 a year and in his petition requested the village authorities to make the reduction retroactive to Jan. 1.

Secretary of Labor Fixes Wage Rates in Salt Lake City

In connection with the controversy over wages to be paid on the federal work being done by the Orndorff Construction Co. in Salt Lake City, Utah, that company has been notified of the wage scale which the secretary of labor has determined as the prevailing one in Salt Lake City and which must be paid to employees on the veterans' hospital and the postoffice addition.

The wage scale decreed by the secretary follows: bricklayers and stonemasons, $11 a day; plasters, $10; carpenters, ironworkers, plumbers, steamfitters, tile setters, electricians and hoisting engineers, $9; cement finishers, painters and sheet metal workers, $8; bricklayers' tenders, $5; roofers, $6.50; plasterers' tenders, $6.50; lathers, 9c. a yard, and common laborers, $4 a day.

Golden Gate Bridge Contracts Extended Six Months

The optional contracts for the major construction features of the Golden Gate Bridge, which were awarded the low bidders July 16, 1931 (*ENR*, July 23, 1931, p. 152), have been extended another six months. At the time the optional contracts were awarded the low bidders agreed to a six months' delay in starting work, pending the sale of the bonds. The case to determine the validity of the bonds and the district's power of taxation, upheld by the California supreme court (*ENR*, Dec. 3, 1931, p. 901), is now before the United States district court.

Rochester Contractors Propose Building Wage Reductions

Building contractors of Rochester, N. Y., have proposed a 20 per cent reduction in wages, effective April 1, when all contracts between unions and contractors of that city expire. Some of the unions are reported to be willing to accept 10 per cent but hesitate at 20 per cent. Building trades wage scales in Rochester by the hour are: electricians, $1.44⅜; masons, $1.58½; carpenters, $1.26½; painters, $1.20; plumbers, $1.50; roofers, $1.15; sheet metal workers, $1.27; marble tile setters, $1.51½. The builders say their requests for lower wages are necessary as a readjustment to meet new conditions and stimulate building.

Philadelphia Dismisses Two Engineers

On orders from Mayor Moore, of Philadelphia, Lieut. Commander Robert S. Hedtler, chief engineer for the Hog Island airport project, and J. Harvey Gillingham, consulting engineer to the director of public works, have been dismissed in the interests of economy. At the same time Frank H. Caven, director of public works, ordered all work stopped at once on the Hog Island air-rail-marine development.

Election Date Is Set for a Vote on All-American Canal Project

CONFIRMATION of the All-American Canal contract will be voted on by the Imperial Irrigation District on Feb. 11. The date was set by a three-to-two vote of the district's board of directors following a favorable report on the project by the California District Securities Commission.

Approval of the contract with the government for the construction of the canal will mean an early start on this $38,500,000 project. The contract form has been approved by the secretary of the interior and the board of directors of the irrigation district, but the approval of the electors is necessary and the election has been held up several months by suits brought by landholder interests.

The findings of the commission and a separate report by State Engineer Hyatt followed many public hearings, and the commission concluded by stating: "Execution of the contract and construction of the works therein provided for will be for the best interests of the district and the landowners, assessment payers and water users thereof, and the same ought to be and hereby is approved."

Four specific findings were included in the commission's conclusions: (1) The supply of water under the proposed contract is and will be ample for the needs of the district as it exists and will be enlarged; (2) the soil of the present and proposed district lands is susceptible to and will benefit by irrigation, and drainage needs for the land have been met and further drainage works will not be required for many years; (3) an adequate irrigation system, except for diversion works and main canal, exists, and these features in the proposed contract are feasible and costs thereof not disproportionate to the benefits; (4) the plans and estimates of cost are adequate and will not be exceeded. The board is composed of U. S. Webb, attorney general; Ed Rainey, state superintendent of banks; Edward Hyatt, state engineer; H. E. Vogel, Fresno Irrigation District, and M. J. Dowd, chief engineer and general superintendent, Imperial Irrigation District. Mr. Dowd was excused from voting on the commission's findings.

In a separate report the state engineer found the contract favorable and the cost justified by the benefits and concluded that "the project as a whole is financially and commercially sound." Further, he pointed out that interest payments are eliminated and principal repayments, beginning after completion of the project, are at a low rate. Also, hydro-electric power possibilities along the canal are reserved to the projects for their development and use.

The directors of the Imperial Irrigation District also set the same date for the recall election of two directors. Petitions for their recall were presented to the board last November.

Tri-State Compact to End Pollution of Water Is Drawn Up

LEGISLATIVE leaders of New York, New Jersey and Connecticut and a commission that has studied for the last year the problems of pollution in the waters adjacent to the three states met last week and drafted a compact linking the states in a movement against pollution through creation of an interstate sanitation district and a permanent commission and the setting up of standards of purity.

The legislators agreed to introduce the necessary bills during the next three weeks at Albany and Trenton and to have public hearings called to obtain public support. Similar action will be taken when the Connecticut legislature meets in 1933, and if the three states enter the agreement final approval will be asked of Congress.

Under the compact the waters of the proposed district would be divided into two classes: the first, waters used for recreation and the breeding of shellfish, and the second, waters for commercial purposes. The standards of the first would be those which now exist for drinking water and the standards of the second sufficiently high to permit fish to live and thrive. A tristate commission of fifteen would be created, the members to serve without pay.

The compact provides that New York and New Jersey each pay 45 per cent of the cost of administering the affairs of the proposed commission and Connecticut pay 10 per cent.

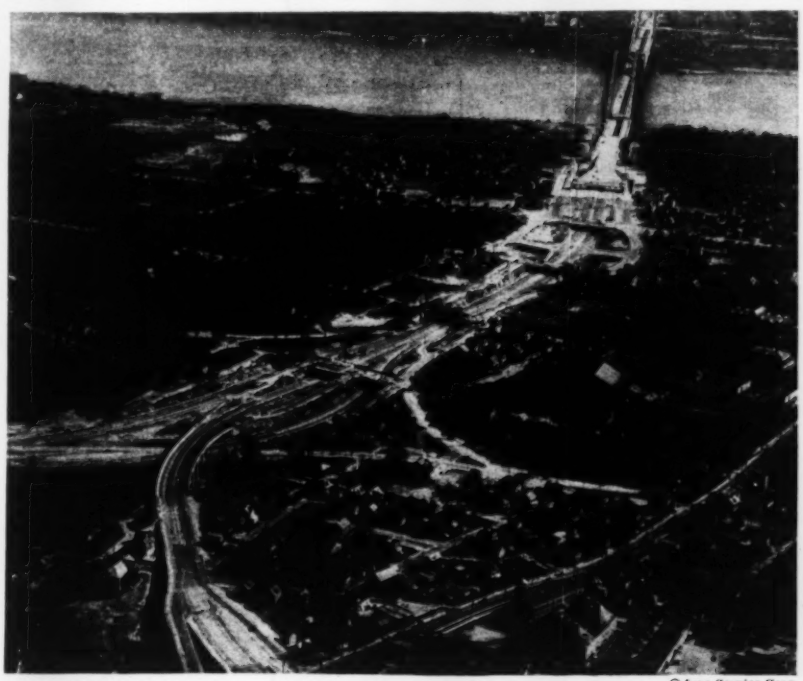
Bill to Protect Water and Sewage Treatment Operators

A bill introduced in the legislature of New Jersey as a supplement to the existing law of 1918 provides that any person now holding the position of superintendent or operator in charge of a water-purification, water-treatment or sewage-treatment plant in any municipality and holding a license as such and who has held such position for five years continuously shall not be removed except for cause and after a trial by the state department of health. The bill specifically provides that such persons shall hold office during good behavior, even though they were appointed for a fixed term, and shall not be removed for political reasons.

An explanatory note appended to the bill states that the object of the proposed legislation is "to eliminate chaotic conditions which arise from placing inexperienced men in charge of water purification or treatment plants or sewage-treatment plants, thereby safeguarding the health of the people in the municipalities of this state."

Atlanta Post Office Contract Awarded

Official announcement is made that the contract for construction of the new post office for Atlanta, Ga., has been awarded by the federal government to the Great Lakes Construction Co., of Chicago. The concern's bid, $1,534,351, was the lowest of a total of twenty submitted. Work on the structure will begin immediately.



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NEW JERSEY APPROACH TO HUDSON RIVER BRIDGE NEARS COMPLETION

With Hudson River bridge traffic using the main central roadway, the New Jersey state highway department is rapidly completing the auxiliary side roads and connections in the elaborate approach layout. The wide toll collection area in the background is illuminated at night from floodlights on top of four tall steel towers. The main roadway, which runs under most of the intersecting streets, emerges onto the high-level viaduct in the foreground that forms the top deck of a three-level crossing, passing over a connecting road from the north (left) and also a north and south road on the lowest level.

Plans Approved for Union Station at Los Angeles

THE California Railroad Commission on Jan. 18 formally approved the plans for a union passenger depot in Los Angeles as presented by the Southern Pacific Co. and the Los Angeles & Salt Lake Railroad Co. (Union Pacific System) and in the same order disapproved the plan presented by the Atchison, Topeka & Santa Fe Railway Co. The approved plan calls for a stub-end depot located in the Plaza area. Estimates of the cost of the structure vary from $8,708,000 to $9,517,000. The Santa Fe plan was for a "through" depot, to cost from $10,324,000 to $13,550,000.

The original order of the railroad commission, made on July 8, 1927, and now standing, directs the Southern Pacific, the Atchison, Topeka & Santa Fe and the Los Angeles & Salt Lake to construct and operate a union passenger station within the Plaza area of Los Angeles, at an approximate cost of $10,000,000.

The commission holds that the Southern Pacific plan just approved is in every way in substantial accordance with the requirements of its own decision and that of the Interstate Commerce Commission in the previous order, which was upheld by both the state supreme court (*ENR*, June 5, 1930, p. 945) and the United States supreme court (*ENR*, May 21, 1931, p. 908).

With the order approving the plan on file, it is now necessary for the railroads to agree upon a distribution of the cost of the structure. Failing to do this, the cost will be allocated by the commission.

Railroad Truck Operation in Massachusetts Declared Illegal

The Boston & Maine and the New Haven railroads are operating buses and trucks illegally in Massachusetts, according to a finding of the state public utilities commission. The commission states that an act passed in 1925 provides, by implication at least, that railroads shall not maintain and operate motor vehicles on the highways of the commonwealth without approval of the department of public works. The commission believes that the obligations imposed by that law cannot be avoided by establishing a wholly owned subsidiary, as is done by both roads.

Hand Labor Unconstitutional, Declares Utah Court

The supreme court of Utah held on Jan. 23 that use of hand labor instead of machines on a public project results in substantial increase in the cost of the project and therefore is unconstitutional.

The court granted a writ of prohibition stopping Salt Lake City from proceeding with the construction of a $600,000 storm sewer on a minimum-wage, hand-labor basis, holding that the program violates a section of the constitution which specifies that money appropriated for one purpose cannot be diverted to another purpose.

Riparian Rights for Proposed California Hydro Plant Defined

Dismissal of a suit through the filing of a stipulation in the superior court in Fresno, Calif., has removed one of the obstacles to construction of the San Joaquin Light & Power Corp.'s proposed 50,000-kw. steam plant at Herndon, 10 miles north of Fresno. The suit involved riparian rights and sought to prevent the power company from taking water from the San Joaquin River. The stipulation contains the provision that the power company may use the water as long as such use does not materially interfere with the flow of the river.

No definite date has been set for the start of construction of the Herndon plant, although early spring has been tentatively mentioned, with the object of having the plant ready for operation by the summer of 1933.

Hoover Dam Notes

Phenomenal progress was maintained in driving the 41x56-ft. enlarged headings in the Hoover Dam diversion tunnels during the two-week period from Jan. 2 to 16, a total of 2,912 ft. being made in eight headings. Progress to Jan. 16 totals 9,701 ft. in all four tunnels. At the present rate the enlarged headings in tunnel No. 3 will hole through around Feb. 1, with those of tunnels No. 2 and 4 following soon after.

* * *

Excavation was started for the Nevada spillway during the week ended Jan. 16. The work at present is being concentrated in the transition section above the spillway inlet portal. A total of 52 ft. of 7x10-ft. pioneer heading has been driven in the inclined Nevada spillway tunnel. This pilot bore is being driven as a top heading and was started from the pioneer bore of the tunnel at the junction of the two tunnels.

* * *

Operation of the 500-ton gravel-screening plant was begun Jan. 9. It is located at the three-way railroad junction in Hemenway Wash. Water for the operation is pumped from the Colorado River by three stages to the clarifier tank on a hill above the screening plant. Two 16-in. pipe lines will furnish water to the screening plant from the clarifier tank.

* * *

The administration and municipal buildings at Boulder City were completed Jan. 10. Six Companies Inc. has completed practically all of the buildings that it has had under construction. The water-distribution system was completed Jan. 9. The filtration plant is 65 per cent complete. The sewer system also has been completed, with the sewage-disposal plant 75 per cent complete.

* * *

The average daily payroll on the project is now $13,100. The total number employed by the principal contractors and by subcontractors on Jan. 16 was 3,121. Of that number 1,050 are ex-service men, and 3,067 of the total are American citizens. The total employed by Six Companies is 2,827; by Carl K. Bryan, truck subcontractor, 132; by Anderson Supply Co., mess subcontractor, 147; by the General Construction Corp., road subcontractor, 147; by other subcontractors, 3.

* * *

The Las Vegas Chamber of Commerce has adopted a resolution recommending that the federal government surrender all rights of taxation to the state of Nevada.

* * *

An employee of Six Companies was fatally injured during the week when he fell from a transformer platform near the outlet portals of the Nevada tunnels.

Low Prices for Water Pipe

The city of Pawtucket, R. I., contracted for its 1932 supply of water pipe Jan. 21 at the lowest price in 25 years, the contract going to the Warren Foundry & Pipe Co. for $28.70 a ton on all sizes ranging from 6-in. to 30-in. Class C cast-iron water pipe. Bidders said the low prices were the result of a desire to keep the plants running. Last year the city paid $41.20 per ton for the same kind of pipe.

Sewage Works Association Meets in New York City

The fourth annual meeting of the New York State Sewage Works Association was held in New York City on Jan. 19, with 120 members and guests registered. At the business meeting Prof. E. B. Phelps, of New York City, was elected president and A. F. Dappert, of Albany, vice-president. A. S. Bedell, state department of health, Albany, was reappointed secretary-treasurer.

At the morning session L. C. L. Smith, engineer member of the Sanitary Commission of New York City, gave a paper on "Governing Features of the Sewage-Treatment Plan for New York City." This was followed by a symposium on "Sludge Handling" consisting of five-minute talks on six different phases by six members. M. M. Aboul Ela, of the municipal engineering staff of Alexandria, Egypt, spoke briefly on the general problem of sewage disposal in Egypt.

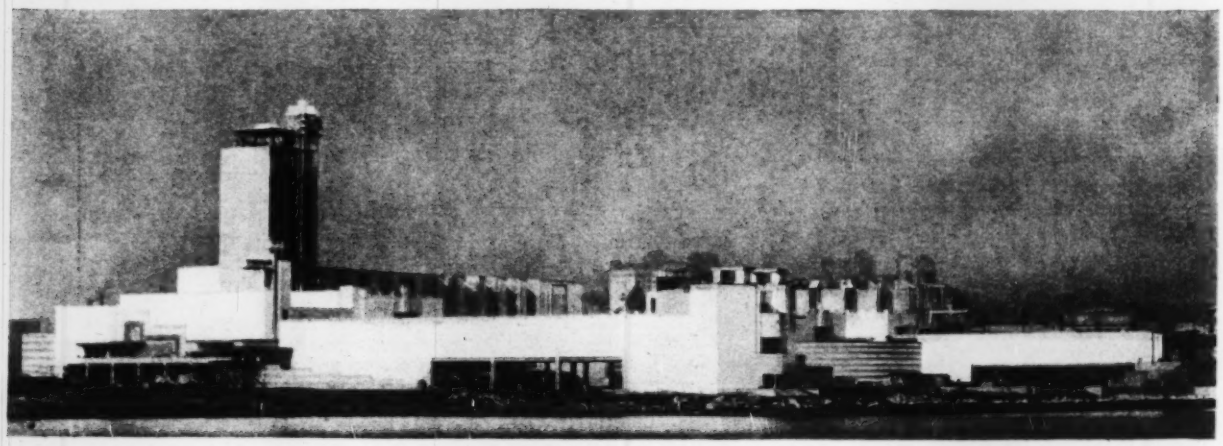
Dr. Carl E. Buck, of the American Public Health Association, gave an interesting talk at the luncheon on "Recent Developments in Public Health Administration," and C. A. Emerson, chairman of the board of control of the Federation of Sewage Works Associations, spoke on the work of the federation.

At the round-table discussion in the afternoon J. F. Skinner led the discussion on "Sewage Sludge as a Fertilizer," Earl Devendorf opened the discussion on "New Kinks in Plant Operation," and L. H. Enslow led the discussion on "Chlorination for B.O.D. Reduction."

The next meeting of the association will be held in Buffalo June 10-11.

Salem, Ore., to Construct Water System

Voters of Salem, Ore., at a recent election approved a bond issue by the city council of $2,500,000, or any smaller sum that is necessary, for the acquisition and construction of a municipal water system. For the issue 2,264 ballots were cast and 1,661 were cast against it.



HALL OF SCIENCE FOR CHICAGO WORLD'S FAIR

This steel-frame building, practically completed, is 700x400 ft. in plan, with two long arms extending to the lagoon. From one of these arms a bridge will extend to an island having a group of exhibition buildings. Two stories and a mezzanine give 408,400 sq.ft. of floor area. The architect was Paul Crot, Philadelphia, Pa. The structural design of the building was prepared by the engineers of the World's Fair, under B. M. Thorud, structural engineer. The McLennan Construction Co. is the general contractor.

Cement Tests to Be Accepted Only From Inspected Laboratories

On and after April 1 the U. S. Bureau of Public Roads will accept reports of cement tests only from those laboratories that have been inspected by the Cement Reference Laboratory at the Bureau of Standards, which is maintained jointly by the American Society for Testing Materials and the federal government. It is expected that this ruling will add considerably to the work of the Cement Reference Laboratory, whose inspections of cement laboratories are made upon request and without charge.

The Cement Reference Laboratory is under the supervision of John R. Dwyer, and it has recently been announced that Mr. Dwyer has been appointed technical assistant to Committee C-1 of the American Society for Testing Materials. Inasmuch as the Cement Reference Laboratory is sponsored by Committee C-1, Mr. Dwyer's new appointment will strengthen the connection between the committee and the laboratory.

Columbia School of Engineering Plans Expansion

Plans for the expansion of the Columbia school of engineering which would entail the expenditure of from $20,000,000 to $25,000,000 are announced by Dean Joseph W. Barker. It is planned to convert the school into an engineering center rivaling in size and scope the present Columbia medical center. Although the plans are tentative as yet, they are understood to have the approval of President Butler and will soon be submitted to the university board of trustees.

The engineering center would be divided, part of it being an enlargement of buildings already on the Morningside campus and the addition of two new structures there. The other division of the center would be erected on a site not yet designated and which would serve as an institute of engineering research.

COSTS AND CONTRACTS

ENR Index Numbers

Cost			Volume		
Jan. 1,	1932	162.48	Dec.,	1931	133
Dec. 1,	1931	166.23	Nov.,	1931	180
Jan. 1,	1931	194.48	Dec.,	1930	192
Average,	1931	181.35	Average,	1931	220
Average,	1930	202.85	Average,	1930	260
1913	.....	100.00	1913	.....	100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of Jan. 28, with some comparisons, total as follows:

(In Thousands of Dollars)

	Jan. 28, 1932	Average of Last Four Weeks 1932	1931
Buildings:			
Industrial	$1,936	$2,180	$2,983
Other	6,871	9,781	17,376
Streets and roads..	4,040	2,785	9,520
Other construction.	9,726	7,930	22,427
Total	$22,573	$22,678	$52,307

Total, all classes, Jan. 1 to Jan. 28:

1932	$90,713
1931	237,738

Interior Department Appropriations Cut in Reported Bill

IN ACCORDANCE with its policy of reducing government expenditures, the appropriations committee of the House of Representatives this week sent the interior department appropriation bill for 1933 to the floor with cuts in practically every item. The total appropriation, $50,431,432, is $18,911,174 less than that for 1932 and $6,273,920 less than the budget estimates.

The total appropriation for the Bureau of Reclamation is $11,089,360, which is $10,981,640 less than the 1932 appropriation and $3,279,000 less than the budget estimate. Included in the funds for the Bureau of Reclamation is an item of $8,000,000 for the Boulder Canyon project. This is $7,000,000 less than the amount allocated to the project last year and $2,000,000 less than the budget estimate for this year. It is stated in the committee report that the reduction under the budget estimate is not to be construed as an expression of opposition to the project. The committee believes, however, that with $1,000,000 still unexpended from 1931 and $15,000,000 still available from 1932, together with the $8,000,000 carried in the present bill, there will be sufficient money to carry the program through the fiscal year of 1933.

No new reclamation projects are recommended in the bill, the funds appropriated being entirely for the continuation of projects already undertaken or for the construction of auxiliary water supplies for the projects now being operated.

The stream-gaging appropriation of $600,000 is $120,000 less than last year's appropriation and $119,500 under the budget estimate.

Cincinnati Opens Viaduct Over New Railroad Terminals

On Jan. 16 the 3,500 ft. double-deck Western Hills viaduct across the new terminal site and Mill Creek valley, Cincinnati, was opened. On the upper deck is a 40-ft. roadway with two sidewalks, but the 40-ft. roadway on the lower deck —for trucks and street cars—has no sidewalks. It consists mainly of concrete and concrete-cased steel girder spans, but Mill Creek and Spring Grove Ave. are spanned by 109-ft. and 120-ft. two-rib open spandrel concrete arches. The viaduct was designed and built under the direction of Henry M. Waite, chief engineer of the Cincinnati Union Terminal Co., but its $3,500,000 cost is shared by the city and the Baltimore & Ohio R.R. The MacDougald Construction Co. had the general contract.

Highway Construction to Stop in North Carolina

All state expenditures in North Carolina must be held to 70 per cent of the appropriations, Governor Gardner warned heads of state departments, whom he called together recently. The governor also said he is considering convening the general assembly in special session in March to take up income tax revenues and highway revenues from automobile licenses and gasoline taxes.

No more money will be spent this year in highway construction, the governor says. For this purpose $4,800,000 was appropriated and contracts have been awarded amounting to $2,000,000. These contracts will be completed, but no new ones made.

The $400,000 appropriated for a new state prison will not be spent but will be put into the general fund.

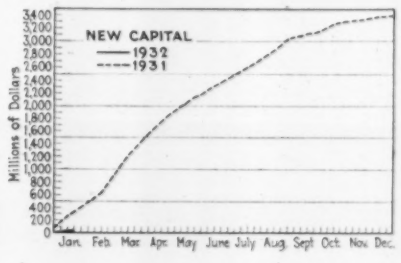
Patent Study Planned

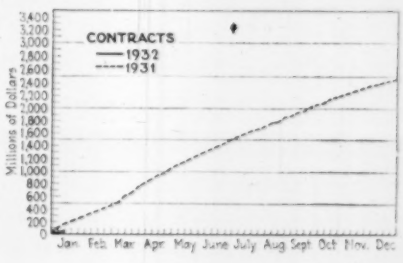
Plans for a comprehensive consideration of the patent, trademark and copyright situation have been made by Congressman Sirovich, of New York, chairman of the House committee on patents. Hearings are now being held and will continue until March 1, and Mr. Sirovich invites leaders of American industry to express their views on the patent needs of the country so that the whole situation may be visualized before legislation is attempted on the subject. The patent committee will meet the convenience of those not residing in Washington and on request will make definite dates for appearance.

Capital and Contracts

New capital for construction issued in the week ended Jan. 23 totaled $7,000,000, a slight improvement over the $5,000,000 for the week of Jan. 16 and $3,000,000 in the week of Jan. 9. The $100,000,000 issue of New York City 6 per cent special corporate stock notes, designed to meet current obligations of the city and not for construction, was of necessity omitted from the weekly total.

Cumulatively, this year's total of $15,000,000 compares very unfavorably with $243,000,000 issued in the corresponding period of January, 1931.





Personal Notes

JOHN R. D. MATHESON, major, Corps of Engineers, who has been serving as district engineer at Sacramento, Calif., has been assigned to duty with the 13th Engineers at Fort Humphreys.

H. D. DEWELL, consulting engineer, of San Francisco, has been appointed a member of the California state board of registration of civil engineers, replacing A. E. GIVEN.

Major HOLLAND L. ROBB, assistant to the engineer commissioner in Washington, D. C., has been transferred to the office of the United States engineer for the Washington district.

JAMES E. FOX, assistant city engineer of Wooster, Ohio, since 1926, has been chosen city engineer, succeeding ARTHUR WEDGE, who has been chosen city manager of Bedford, Ohio.

E. S. PENNEBAKER, for sixteen years a member of the engineering staff of the Texas & Pacific Railway Co., has been named general manager of the terminal railway and port facilities owned jointly by the Texas & Pacific and the Missouri Pacific lines at New Orleans.

Colonel A. T. SCHENCK, who was recently appointed construction engineer in the office of the supervising architect, U. S. treasury department, and assigned to duty on the federal office building under construction in Seattle, Wash., has been transferred to Portland, Ore., where he will be similarly employed on the new post office building there.

JOHN R. FORDYCE, of Hot Springs, Ark., and CLIFFORD OLDER, of Chicago, have been selected by the state highway audit commission of Arkansas to check construction projects, materials and equipment in connection with the five-year audit of the state highway department now in progress.

MAX T. GREY, of the engineering firm of Haggey, Grey & Plunkett, has been engaged as engineer for the town of Fort Erie, Ont., for one year.

FRANK W. BIRD, a civil engineer for the past twenty years with the Montana Power Co., with headquarters in Butte, Mont., has been appointed assistant general manager for that company and its subsidiary companies.

JOHN CARLIN, assistant city engineer of Sydney, N. S., under R. M. McKinnon, who has resigned to become assistant city engineer of Halifax, has been appointed acting city engineer. There are nine applicants for the permanent post, but the city council has deferred selection until spring.

GEORGE E. WARREN, assistant general manager, Portland Cement Association, Chicago, has been transferred to San Francisco, where he will reopen the regional office and will carry on work of the association in that territory with the title of acting regional manager, Pacific Coast district.

MAX C. TYLER, lieutenant colonel, Corps of Engineers, who has been serving in the office of the Chief of Engineers in Washington since retiring as the chief engineer of the Federal Power Commission, has been assigned to duty as assistant to the division engineer at New Orleans.

G. DONALD KENNEDY, director of water supply of Pontiac, Mich., has been selected as the man in Pontiac under 35 years old who performed the greatest public service during 1931. Mr. Kennedy is credited with having made an exhaustive study of the city's underground water-supply and pumping facilities and with making possible a reduction in water rates.

Obituary

E. J. MOLERA, of San Francisco, consulting engineer and architect, died on Jan. 14 at the age of 84. Mr. Molera, a native of Barcelona, Spain, and a graduate of the Academy of Royal Engineers-Guadalajara, Spain, went to San Francisco in the seventies. For some time he was associated with the United States rivers and harbors work around the San Francisco Bay district, and assisted in survey work on the Sacramento and Columbia rivers. In 1875 he went into private consulting practice.

RICHARD STRESAU, of Milwaukee, died suddenly of heart failure in his office on Jan. 13. Mr. Stresau was born in Galveston, Tex., 51 years ago and was graduated from the Massachusetts Institute of Technology in 1904. During the war he did engineering work for the government and in 1919 joined the A. O. Smith Corp., with which he was connected at his death. Mr. Stresau was noted for his contributions in the field of electric welding and was largely responsible for the development of the welding process employed by that company and its application to the manufacture of couplings, pressure vessels and pipe.

BARKSDALE HALES, civil engineer and since 1924 superintendent of construction for the FitzGerald Engineering & Construction Co., of Los Angeles, died on Jan. 10. Mr. Hales was a native of Virginia, but went to Los Angeles 26 years ago. He was active in the engineering and construction work of the Southern Pacific Railroad development in Mexico, with Stone & Webster on the Big Creek project, and on highway and irrigation development in California, Arizona, New Mexico and Colorado. Mr. Hales served as an officer in the Corps of Engineers, U.S.A., during the World War with the American Expeditionary Forces in France. He was 43 years old.

WILLIAM FRANCIS TYE, assistant chief engineer of the Canadian Pacific Railway system in 1902-04 and chief engineer in 1904-06 died in Paris on Jan. 9. Mr. Tye was 71 years old and was a member of the Institution of Civil Engineers (England), Engineering Institute of Canada, American Society of Civil Engineers, American Institute of Consulting Engineers and American Railway Engineering Association.

THOMAS BOWES, division engineer in the sewer division of the public works department of Boston, Mass., died in Bath, N. Y., on Jan. 24. Mr. Bowes was 62 years old. He was a graduate of the engineering school of Cornell University, class of 1891, and was a member of the Engineering Societies of Boston.

MARK STEWART, of Memphis, Tenn., a civil engineer with the S & W Construction Co., died on Jan. 17 from injuries received in an automobile accident. Mr. Stewart, who was 49 years old, was a graduate of Washington and Lee University.

ROBERT L. OWENS, who until he retired because of failing health about a year ago was secretary-treasurer and general manager of the Champion Bridge Co., of Wilmington, Ohio, died recently in Ironton, Ohio, at the age of 66 years.

SOCIETY CALENDAR

AMERICAN CONCRETE INSTITUTE, Detroit; annual convention, Washington, D. C., March 1-4.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago; annual convention, Chicago, March 15-16.

ENGINEERING INSTITUTE OF CANADA, Montreal; 46th annual meeting, Toronto, Feb. 3-5.

NATIONAL PAVING BRICK ASSOCIATION, Washington; annual meeting, Chicago, Feb. 10-12.

AMERICAN CERAMIC SOCIETY will hold its 34th annual meeting in Baltimore Feb. 8-12. In connection with this meeting there will also be a meeting of the National Brick Manufacturers Research Foundation.

AMERICAN WATERWORKS MANUFACTURERS' ASSOCIATION will meet in Memphis, May 2-6.

GENERAL CONTRACTORS ASSOCIATION of Vancouver, B. C., at its annual meeting recently elected the following officers: president, J. P. Hodgson; first vice-president, W. E. Jenkins; second vice-president, Alec Smith.

INTERMOUNTAIN BRANCH, Associated General Contractors of America, at its annual convention in Salt Lake City on Jan. 14 elected officers as follows: president, G. H. Malan, Ogden, Utah; vice-president, H. T. Reynolds, Springville, Utah; secretary-treasurer, T. C. Sorensen, Salt Lake City.

LOUISIANA ENGINEERING SOCIETY at its annual meeting on Jan. 17 elected as president Fred N. Billingsley, head of the Billingsley Engineering Co., of New Orleans. Other officers elected were: vice-president, John H. O'Neill; secretary, Frank A. Muth; treasurer, Walter B. Moses.

PACIFIC NORTHWEST SECTION, American Water Works Association, will hold its fifth annual meeting in Wenatchee, Wash., May 5-7.

SAN DIEGO CHAPTER, Associated General Contractors, has chosen officers as follows: president, George R. Daley; vice-president, Morley H. Golden.

SAN DIEGO ENGINEERS' CLUB has chosen the following officers: president, Byrl D. Phelps; vice-president, E. L. Freeland; secretary, H. H. Allen; treasurer, Harry Haelsig.

SAN DIEGO SECTION, American Society of Civil Engineers, has elected the following officers: president, Charles P. Williams; vice-president, R. Robinson Rowe; secretary, Paul Beerman.

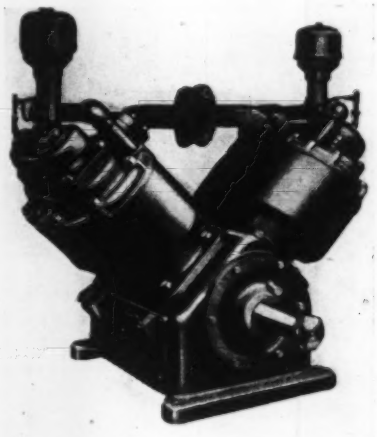
SPOKANE CHAPTER, Associated General Contractors of America, at its annual election chose the following officers: president, Max J. Kuney; vice-presidents, I. G. Anderson and Nick Norman; secretary, Dan Hannah (reelected).

TEXAS SECTION, Southwest Waterworks Association, met at Mineral Wells on Jan. 20 and elected officers as follows: president, J. B. Winder Dallas; vice-presidents, W. J. Miles, Mineral Wells; A. H. Douglas, Wichita Falls; L. R. Simmons, Grand Saline; W. M. Joiner, San Marcos. Jacksonville, Tex., was selected as the next meeting place.

Construction Equipment and Materials

New Air-Compressor Series

Special valve and cylinder head design to reduce carbon deposits, a unique oiling system and roller-bearing crankshafts are features of a new group of air compressors developed by the Curtis Pneumatic Machinery Co., St. Louis, Mo. The complete line comprises seven models: five of the two-cylinder type with displacements of from 25 to 125 cu.ft., and two of the four-cylinder type with displacements of 115 and 262 cu.ft. Units are furnished a stationary simple compressors for belt drive or as complete self-contained units, either direct-connected or driven by Multiple "V" belts, for stationary or portable service.



V-type air compressor.

Valves are of the light disk type, double heat-treated and made of rust-resisting metal. The head design delivers air into the cylinder at the lowest possible temperature through short intake passages and large ports giving a straight-line air flow. Carbon formation on the valves is held to a minimum by the low air temperature.

Lubrication is by the Curtis "Centro-ring" method. A large-diameter ring operating at slow peripheral speed carries oil to the crankshaft midway between the bearings. From this point it is delivered by centrifugal force through large oil ducts to each throw, thereby oiling connecting rod bearings under constant pressure feed. The large steel ring is the only moving part of this system.

The main bearings are Timken roller bearings so mounted as to preserve the rigidity of the shaft and to take care of any thrust loads that may arise during operation.

Tight-Seating Valve

Manufacturing and sales rights for a valve designed and perfected by P. K. Saunders, a mining engineer in South Africa, have been acquired by the Hills-McCanna Co., 2349 Nelson St., Chicago, Ill. This valve was designed to function without the use of metal-to-metal seats, which are often held partly open by scale and other foreign substances. It has no stem packing or stuffingboxes, all working parts being protected by a diaphragm. Access to the bonnet or body does not require removal of the valve from the line. Corrosion-resisting valves can be produced at a reasonable cost because the design requires that only the body be cast in special metals.

Diaphragm valve in open position.

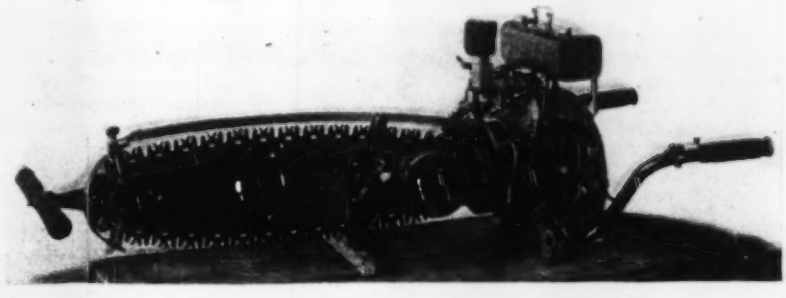
Small Air-Cooled Gasoline Motor

Aircraft practice has guided the Reed-Prentice Corp., Worcester, Mass., in designing a lightweight self-contained air-cooled gasoline motor to drive its power saws, which are also available for electric or compressed air operation. The new motor is of the two-cylinder opposed four-cycle type, with a bore of 2½ in. and a stroke of 2½ in. It develops 8 hp. at 3,600 r.p.m. and weighs only 46 lb. Ignition current is provided by a Bosch flywheel-type magneto. Both crankshaft and cam shaft are mounted on ball bearings. Engine speed is controlled by a rolling motorcycle-type throttle, and it is stopped by a thumb latch which breaks the ignition connection. In starting, the motor is turned over by a cord, a system in widespread use with outboard motors.

The flywheel of this gasoline motor is cast in the form of an 11-in. fan which supplies a blast of air forced around the cylinders by a housing of magnesium metal. Connecting rods are drop forged, machined all over, and connecting rod bearings are of the roller type. Lubrication is supplied from an oil tank to one cylinder and by splash to the opposite cylinder.

While designed primarily for use with the Wolf timber sawing machine, this small motor will also be marketed separately and should find ready application in the construction and industrial fields.

Timber saw with light gasoline power unit.



Bituminous Premixing Plant

Bituminous or asphalt paving materials for either hot or cold application on low-cost roads can be mixed efficiently in the new model CM-2 premixing plant manufactured by the Chausse Oil Burner Co., Elkhart, Ind. The equipment comprises a complete asphalt plant built in two units, both mounted on steel wheels with solid rubber tires. One unit is the drier, equipped with oil burners. Aggregate is fed directly into a large hopper, from which it passes into a rotating drier. It is thoroughly dried, heated to 300 deg. F. and discharged into the bottom of an elevator attached to the second unit. From the elevator the heated aggregate is discharged through a self-measuring device into a continuous blade pug mixer. At the same time bituminous oil or asphalt, previously heated in a 950-gal. tank equipped with oil burners, is pumped through a measuring device adjustable so that any amount of bitumen up to 12 per cent can be included in the mix. The two elements are thoroughly mixed in the pug mill, which is 9 ft. long, and then are dropped into a storage bin with a movable bottom gate, operated by the truck driver into whose truck the material is discharged.

The entire machine weighs 26,000 lb. and can be set up for operation in about one day. Equipment includes two Hercules industrial-type gasoline engines of 30 and 40 hp.; Twin Disc clutches, Cotta reducing transmissions and Worthington air compressor. The manufacturer quotes figures indicating that this outfit will produce material for hard surface pavement at a cost of about $5,000 per mile, or $1,500 per mile per inch of compacted thickness 20 ft. wide.

Although designed to mix hot materials for either cold or hot application, in cases where a paving mix is desired which is mixed cold, the heating and drying unit of the plant may be omitted and only the mixing unit used.

Current Construction Unit Prices

Two Incinerators for Washington, D. C.

BIDS were received Dec. 8, 1931, on two incinerators for Washington, D. C. Contracts were awarded as follows: O St. plant, 24-hour capacity 425 tons, to Rust Engineering Co., Koppers Bldg., Pittsburgh, $321,426, or $756 per ton capacity; Georgetown plant, capacity 170 tons, to North Eastern Construction Co., 101 Park Ave., New York, $169,268, or $996 per ton capacity. Complete list of bids is given below with order given in parentheses.

	O St. Plant			Georgetown Plant		
Rust Engineering Co., Pittsburgh	$321,426	(1)	$756	$175,000	(4)	$1,029
North Eastern Construction Co., New York	329,109	(2)	774	169,268	(1)	996
W. P. Thurston Co., Inc., Richmond, Va	331,000	(3)	779	171,000	(2)	1,006
George E. Wyne, Washington, D. C	342,000	(4)	805	172,000	(3)	1,012
Newport Contracting and Engineering Co., New London, Conn	345,000	(5)	812	176,500	(5)	1,038
Arthur L. Smith & Co., Washington, D. C	352,400	(6)	829	180,000	(6)	1,059
Court Construction Corp., New York	362,000	(7)	852	190,450	(9)	1,120
W. P. Rose Co., Goldsboro, N.C.	368,000	(8)	866	186,300	(7)	1,096
Union Paving Co., Washington, D.C	380,210	(9)	895	189,947	(8)	1,117
John W. Cooper Co., Inc., Buffalo	381,715	(10)	898	192,935	(11)	1,135
S. M. Siesel Co., Milwaukee	384,011	(11)	904	199,900	(12)	1,176
M. A. Long Co., Baltimore, Md.	384,280	(12)	904	192,900	(10)	1,135
J. Henry Miller, Inc., Baltimore	389,670	(13)	917	202,700	(13)	1,192
Lovering-Longbotham Co., St. Paul, Minn	395,379	(14)	930	202,879	(14)	1,193
Fidelity Construction Co., Cleveland	395,500	(15)	931	217,000	(22)	1,276
Dresser Co., Cleveland	400,260	(16)	942	213,000	(20)	1,253
F. H. McGraw & Co., New York	405,800	(17)	955	208,150	(16)	1,224
Hunkin-Conkey Co., Cleveland	407,446	(18)	959	209,519	(17)	1,232
Bahen & Wright, Washington, D.C	410,174	(19)	965	212,093	(19)	1,248
J. L. Robinson Construction Co., Baltimore, Md	413,610	(20)	973	213,978	(21)	1,259
Superior Incinerator Co. of Texas and J. L. Meyer, Dallas, Tex.	414,300	(21)	975	210,200	(18)	1,236
Pittsburgh-Des Moines Steel Co., Pittsburgh	419,800	(22)	988	207,700	(15)	1,222
Hiler Engineering & Construction Co., Brooklyn, N. Y.	458,226	(23)	1,078	260,192	(24)	1,531
John Johnston Construction Co., Buffalo	461,040	(24)	1,085	224,900	(23)	1,323

Red Mountain Bar Siphon of Hetch Hetchy, Calif.

A RIVETED steel siphon 9½ ft. inside diameter, 1,700 ft. long, completing the Hetch Hetchy aqueduct where it crosses the Tuolumne River Canyon at Red Mountain Bar, was awarded Oct. 28, 1931, by the city and county of San Francisco to MacDonald & Kahn Co., Ltd., San Francisco, for $174,369. The pipe connects the foothill tunnels with a portion of the siphon already constructed. It is laid in a trench, on steel bents on concrete piers. Included also in the contract are a reinforced-concrete sand trap, a steel standpipe, a timber trestle carrying a railroad over the pipe, and a concrete wasteway and control structure.

Riveted pipe is of two types: (1) double-riveted lap joint pipe, having double-riveted lap longitudinal and circumferential joints; (2) triple-riveted double-butt strap pipe, having triple-riveted double-butt strap longitudinal and circumferential joints. Items 1 to 8 are for furnishing and installing the pipe.

Items 9 to 20 include furnishing and installing expansion joints, manholes, nozzles, structural steel bents, and steel standpipe. Items 21 to 24 are for clearing right-of-way, excavating and backfilling the trenches. Items 25 and 26 cover the concrete piers and other concrete structures.

Concrete is of two classes proportioned as follows: A, 6.75 gal. water per sack cement, 6 sacks cement per cubic yard concrete in place, 1¼-in. coarse aggregate, 4 to 8 in. slump; C, 8 gal. water, 4 sacks cement, 3-in. aggregate, 1 to 3 in. slump. Class A concrete is used for thin walls and light sections, as valve boxes, the sand trap and wasteway structure. Class C is for piers.

Unit prices are given of the lowest two bidders, both of San Francisco: (A) MacDonald & Kahn, contract, $174,369. (B) Youdall Construction Co., 215 Market St., $207,188. M. M. O'Shaughnessy is city engineer.

Items 1–8, Riveted Steel Pipe, 9½ Ft. I.D. Double-Riveted Trap	A	B
518 ft. ½-in. plate	$42.00	$37.34
164 ft. 7/16-in. plate	46.00	43.29
Triple-Riveted Double Strap		
185 ft. 7/16-in. plate	46.00	42.37
161 ft. ½-in. plate	53.00	48.59
132 ft. 9/16-in. plate	59.00	55.54
84 ft. ⅝ in. plate	63.00	60.30
352 ft. 11/16-in. plate	73.00	68.40
23 ft. ¾-in. plate	75.00	73.28
Items 9–20, Apurtenances:		
Seven expansion joints	900.00	1,406.00
Four manholes	100.00	128.00
1,500 lb. saddle nozzles	0.25	0.31
10,000 lb. companion flanges	0.20	0.31
80,000 lb. str. steel bents	.10	.18
23,000 lb. castings for bents	.20	.26
23,000 lb. taper sections	.10	.17
7,500 lb. bumped heads	.12	.25
22,000 lb. stiffener and anchor rings	.10	.14
Standpipe	1,200.00	1,708.00
4,000 lb. misc. steelwork	.15	.20
60,000 lb. misc. metalwork (install only)	.13	.13
Items 21-24, Excavation:		
3,500 cu.yd. earth excav	1.25	2.20
400 cu.yd. earth ex. for covered sec. waste conduit	1.75	4.00
6,500 cu.yd. rock excav	2.50	2.20
350 cu.yd. rock in covered section waste conduit	3.50	4.00
Items 25-27 Concrete:		
550 cu.yd. Class A	20.00	38.00
700 cu.yd. Class C	15.00	26.00
100,000 lb. reinf.-steel	.045	.06
Items 28-29 Timber Trestle:		
25 M. ft. b.m. timber	80.00	120.00
100 cu.yd. rock ballast	3.00	3.50
Total	$174,369.00	$207,187.54

Dredging in New York Harbor

ANCHORAGE Channel, in the upper bay of New York harbor, is being dredged for a distance of 6,840 ft. Depth is 40 ft. below mean low water, width 400 to 1,300 ft., and yardage is 1,172,000. U. S. Engineer Office, New York, let contract in November, 1931, to the National Dredging Co., 233 Broadway, New York, for $193,246, or $0.1649 per cubic yard.

Physical data for the area to be dredged are as follows: tidal current, 2.3 miles per hour; no bridges; two water mains at 53 ft. below mean low water. Current depth of the area is 30 ft. below mean low. There is heavy traffic of miscellaneous craft. Material is sand and mud. Average haulage is 20 miles, maximum 21 miles. Work started the first of the year, by the hydraulic method; completion in three months.

Prices are given of the six bidders:

National Dredging, New York	$0.1649	$193,246
Morris & Cummings, New York	.1935	226,762
Eugene Breymann, New York	.24	281,256
Central Dredging, Chicago	.2444	286,412
Great Lakes Dredge & Dock, New York	.2574	301,647
Arundel Corp., Baltimore	.4938	578,684

Dredging Waterway in Louisiana

ATCHAFALAYA-VERMILION section of the Louisiana and Texas Intracoastal Waterway is 25.6 miles long and comprises 4,989,000 cu.yd. U. S. Engineer Office, New Orleans, let the contract in June, 1931, to the McWilliams Dredging Co., New Orleans, for 6.6c. per cubic yard. Next three unit prices were 8c., 8.65c. and 8.74c. Material is soft muck underlain by stiff clay to depth of cut, which is 9 ft. below mean Gulf level over a bottom width of 100 ft.